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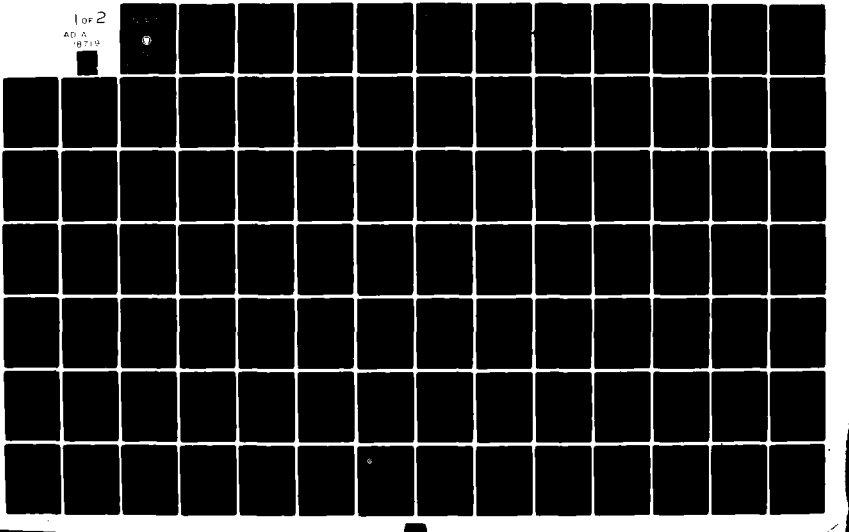

STUDY REPORT
CAA-SR-82-6

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SELECTIVE REENLISTMENT BONUS (SRB) STUDY

AUG 1982

PREPARED BY

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The SRB Study determined the historical effect that SRBs have had on reenlistment rates through a multiple stepwise regression analysis of data from Jan 76 through Jun 81. Data analyzed for each MOS/zone consisted of reenlistment rates, migration rates, SRB multipliers assigned, unemployment rates, military/civilian pay ratio and the Consumer Price Index. The SRB regression coefficient resulting from the analysis represented the net change in a reenlistment rate for an MOS/zone brought about by a change in the SRB multiplier. The SRB		

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regression coefficients were applied to current reenlistment rates, adjusted for migration, to estimate the reenlistment rates that could be achieved at each multiplier level. These estimated reenlistment rates by multiplier for each MOS/zone were used in the SRB allocation methodology developed. Selection criteria to determine which MOS/zones were most critical to receive an SRB were identified, data ranges and value weights were assigned to each criterion, and an importance factor was developed for each criterion. Criticality weights for each MOS/zone were then computed using a weighting technique. These criticality weights were also used in the SRB allocation methodology developed. The SRB allocation methodology used as input for each MOS/zone, the number of reenlistments required, the number of personnel eligible to reenlist, the individual payments, the estimated reenlistment rate by multiplier, and the criticality weight. Reenlistments, and costs and criticality weight points associated with the reenlistments were projected for each SRB multiplier level of an MOS/zone. The Mixed Integer Program of the Functional Mathematical Programming System (MIP-FMPS) then compared costs and critica ty weight points of all MOS/zones to determine the most cost effective allocation of funds using a constrained budget. The output from the allocation methodology listed all the MOS/zones and the multiplier assigned by the MIP-FMPS to each, the reenlistments associated with that multiplier, and the costs and criticality weight points associated with the reenlistments. The allocation methodology was tested using FY 80 data and compared the allocation results with the MILPERCEN FY 82 SRB Program allocation based on the same data.

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SELECTIVE REENLISTMENT BONUS (SRB) STUDY

August 1982

Prepared by

Requirements Directorate

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DEPARTMENT OF THE ARMY
US ARMY CONCEPTS ANALYSIS AGENCY
8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20814

REPLY TO
ATTENTION OF

CSCA-RQP

1 August 1982

SUBJECT: Selective Reenlistment Bonus (SRB) Study

Deputy Chief of Staff for Personnel
Department of the Army
ATTN: DAPE-MPR
Washington, DC 20310

1. Reference letter, DAPE-MPR-RE, 17 September 1981, subject as above.

2. Referenced letter directed the US Army Concepts Analysis Agency (CAA) to develop an improved methodology for the allocation of selective reenlistment bonus (SRB) funds and to analyze the historical effectiveness of SRBs.

3. Attached is the final report which documents the analysis of SRB effectiveness and the development of an SRB allocation methodology. The study report discusses the manner in which the study was conducted; the current SRB program; the development and analysis of the effectiveness, criticality selection criteria, allocation methodologies developed, and observations resulting from the study.

4. This Agency expresses appreciation to all commands and agencies who have contributed to this product. Questions and/or inquiries should be directed to the Chief, Personnel, Logistics, and Resource Analysis Group (ATTN: CSCA-RQP), Requirements Directorate, US Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, Maryland 20814 (Telephone: 202-295-5251).

David C. Hardison

DAVID C. HARDISON
Director

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SUMMARY

1. STUDY PURPOSE. The purpose of the Selective Reenlistment Bonus (SRB) Study is to develop a formalized methodology for more effective allocation of SRB funds. An associated purpose is to analyze the historical effectiveness of SRBs.

2. BACKGROUND. An audit in 1980 by the US Army Audit Agency (USAAA) of the Army Bonus Program indicated that improvement was needed in the managerial procedures used to determine which military occupational specialties (MOS) receive SRBs. In addition, it found that the effectiveness of bonuses in retaining personnel in these MOSs had not been determined. On 17 September 1981, the US Army Concepts Analysis Agency (CAA) was formally tasked by the Office of the Deputy Chief of Staff for Personnel (ODCSPER), Headquarters, Department of the Army (HQDA) to develop an improved methodology for allocation of SRB funds and to analyze the historical effectiveness of SRBs.

3. OBJECTIVES. The objectives of the study are as follows:

a. Determine the past effect of SRBs on reenlistment rates.

b. Examine the impact of exogenous variables, such as unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio, on bonus induced reenlistment rates. Identify those exogenous variables which have had a significant influence upon reenlistment rates.

c. Select parameters to identify and rank candidate MOSs, and establish criteria to determine which are critical to the defense mission and should be candidates for award of an SRB.

d. Determine the kind and frequency of analysis that must be made to allocate SRB funds more effectively.

e. Develop the methodology for allocation of SRB funds to the point where the study sponsor will be able to utilize an automatic data processing (ADP) system in implementation.

4. METHODOLOGY. The study was conducted in four phases as depicted in Figure 1. The background phase provided the study team with a working knowledge of SRB Program policies and procedures, data available, existing models and methodologies, and tools and techniques for model and methodology development. During the development phase, relevant data were selected, tools and techniques were used to manipulate the data, and effectiveness, criticality selection criteria, and allocation methodologies and models were developed. In the application phase, test data were run through the models to ensure the workability of the models and the validity of the methodologies that had been developed. During the evaluation phase, output from the models was analyzed, and adjustments were made to fine tune the models and methodologies. In addition, the final report, which was drafted and refined as the four phases were performed, was finalized and published.

5. ESSENTIAL ELEMENTS OF ANALYSIS (EEA). The answers to the EEA specified in the study directive are summarized below.

a. What effect have SRBs had on reenlistment rates? Multiple regression analysis was used to explain the impact of the SRB on reenlistment rates from a historical perspective. MOSs with similar skills were consolidated into 10 occupational skill groups. Each skill group was evaluated in the three zones in which Army personnel are eligible to receive an SRB; Zone A equals 21 months to 6 years of service (YOS), Zone B equals 6 to 10 YOS interval, and Zone C equals 10 to 14 YOS interval. The analysis showed that skill group reenlistment rates responded positively to changes in the amount of the SRB for personnel serving in Zones A and B. Since the SRB was first offered to Zone C personnel in 1980, there has been less opportunity for them to respond and, therefore, the evidence of SRB impact on this group is less convincing.

b. What influence have exogenous variables (unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio) had on reenlistment rates? The CPI was positively correlated with reenlistment rates. Neither the unemployment rate nor the MP/CP ratio was consistently correlated with the historical reenlistment rates, and therefore their influence on reenlistment rates was inconclusive.

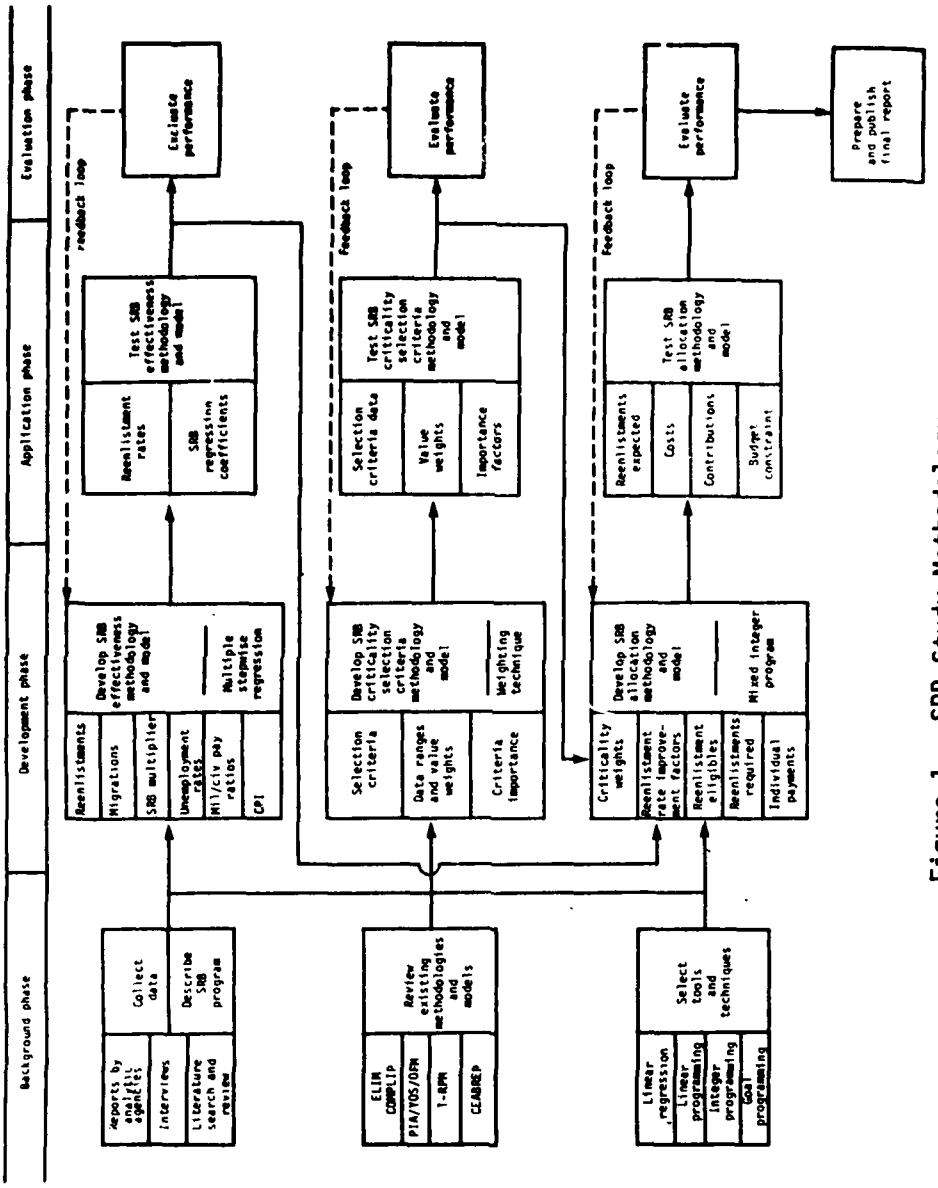

Figure 1. SRB Study Methodology

c. What are the most important selection criteria to consider when selecting an MOS for the SRB Program? Nine selection criteria were identified, with ODCSPER and US Army Military Personnel Center input, to be the most important considerations to the selection of an MOS for the SRB Program. They are listed below in descending order of importance.

(1) Mission essentiality of the MOS.

(2) Reenlistment rate of the zone within the MOS.

(3) Reenlistment migration rate of the zone within the MOS.

(4) Percent personnel fill desired in the zone within the MOS.

(5) Percent personnel fill desired in the MOS.

(6) Replacement training cost for the zone within the MOS.

(7) Percent personnel fill of the zone within the MOS.

(8) Percent personnel fill of the MOS.

(9) Density of the MOS.

d. What kind and frequency of analysis must be performed to effectively allocate SRB funds? Frequent runs (at least quarterly) of the allocation model should be made during the interval between the first budget submission and the time when budget adjustments are no longer permitted. Inputs to the allocation models, such as the number of reenlistments required, the eligibles, the average SRB payment per reenlistment, the current reenlistment rate, the current SRB multiplier, and the criticality weights, must be updated each time the allocation model is run. Historical SRB effectiveness factors should be valid for at least 2 years.

e. What kinds of data will be needed to use the proposed SRB methodology? Principal inputs to the proposed methodology are:

(1) Historical measures of SRB effectiveness (skill group SRB coefficients).

(2) Assessments of the relative importance to the Army of reenlistments in Army skills (as represented by the MOS/zone criticality weights).

(3) Current MOS/zone information such as:

(a) Reenlistments required.

(b) Eligibles.

(c) Reenlistment rate and SRB multiplier.

(d) Average SRB payment per reenlistment.

f. What data not currently available must be gathered so that the proposed methodology can be implemented? What time span should the data cover?

(1) All data required by the methodology are available, although they are not all automated and integrated in the format required to implement this methodology. In the absence of a viable alternative, many of the data inputs to support development of the criticality and allocation methodologies were taken from the Army's proposed SRB Program as submitted to the Office of the Secretary of Defense (OSD) in May 1981. Future efforts should focus on the development of an automated source of these data, namely, the selection criteria elements, reenlistments required, eligibles, and current reenlistment rates.

(2) The appropriate time span for data depends on the particular part of the methodology concerned. At least 5 years of data are needed to reevaluate SRB effectiveness. The time span of selection criteria data on which criticality weights are based may be 1 year or several years. Study criticality weights were based on 1 year (FY 81) due to the limited availability of automated data.

6. OBSERVATIONS. The key observations resulting from this study are as follows:

a. Evaluation of historical reenlistment data revealed limited positive correlation between SRB levels and reenlistment rates by either MOS or CMF groups.

b. For study purposes, 10 new skill groups were developed which aggregate similar skills horizontally across existing MOS/CMF groups; evaluation produced positive correlation between SRB payments and reenlistment rates, using these new skill groups.

c. The national unemployment rate and the ratio of military pay to civilian pay did not appear to have any consistent influence on projecting reenlistment rates.

d. The application of the SRB allocation methodology developed in this study appears to provide a higher level of effectiveness (measured in projected critical skill reenlistments) for a given SRB budget than did the current Army SRB allocation methodology.

e. The concept of criticality weights provides a useful tool for determining the relative importance of reenlistments in a specified MOS/zone as compared to all other MOS/zones. However, the value of the criticality weight is very sensitive to the selection of the attributes used in its determination.

f. The SRB allocation methodology produces significantly different results depending on whether the criticality weight is assigned as the utility of the required reenlistments in the MOS/zone or as the utility of each reenlistment in the MOS/zone.

g. Several vital MOSs appear insensitive to the concept of an SRB bonus, regardless of level; a nonmonetary incentive may be needed to supplement the effect of the SRB bonus in inducing reenlistments in these few vital skills.

CONTENTS

FIGURES

TABLES

SELECTIVE REENLISTMENT BONUS (SRB) STUDY

CHAPTER 1

INTRODUCTION

1-1. STUDY PURPOSE. The SRB Study develops, using current regulatory guidance, a formalized methodology for more effective allocation of SRB funds. In addition, it analyzes the historical effectiveness of SRBs.

1-2. BACKGROUND. This study was requested by the US Army Military Personnel Center (MILPERCEN) following an audit of the Army Bonus Program conducted by the US Army Audit Agency (USAAA). The audit indicated that improvement was needed in managerial procedures used to determine which military occupational specialties (MOS) receive SRBs and whether the bonuses are effective in retaining personnel in these MOSs. On 17 September 1981, the US Army Concepts Analysis Agency (CAA) was officially tasked by the Office of the Deputy Chief of Staff for Personnel (ODCSPER), Headquarters, Department of the Army (HQDA) to study these issues. That directive is at Appendix B of this study. It provides for the establishment of a study group to develop an improved methodology for allocation of SRB funds and to analyze the historical effectiveness of SRBs. The directive required that a final report be published by 15 July 1982.

1-3. PROBLEM. The SRB study directive defines the problem as follows. The current method of determining MOSs to receive SRBs and of designating award levels is a subjective analysis, using manual procedures, without assurances that the bonuses offered are to the skills having the greatest need and are effective for these skills.

1-4. OBJECTIVES. The objectives of this study are to:

a. Determine the past effect of SRBs on reenlistment rates.

b. Examine the impact of exogenous variables, such as unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio, on bonus induced reenlistment rates. Identify those exogenous variables which have had a significant influence upon reenlistment rates.

c. Select parameters to identify and rank candidate MOSs and establish criteria to determine which are critical to the defense mission and should be candidates for award of an SRB.

d. Determine the kind and frequency of analysis that must be made to allocate SRB funds more effectively.

e. Develop the methodology for allocation of SRB funds to the point where the study proponent will be able to utilize an automatic data processing (ADP) system for implementation.

1-5. SCOPE. The study encompasses a review of current directives and procedures governing the SRB Program. Historical reenlistment and bonus data in conjunction with data on exogenous variables are analyzed to determine the past effect SRBs have had on reenlistment rates. Criteria are identified that are necessary to determine the priority of MOSs to receive SRBs. Personnel shortfalls/reenlistment projection data, SRB effectiveness data developed, and criticality selection criteria identified are used in an integer linear program to develop an SRB allocation methodology.

1-6. ASSUMPTIONS. The study was conducted using the following assumptions:

a. Certain MOSs are more critical to accomplishment of the defense mission than others.

b. A combination of factors, e.g., reenlistment rates, career manning levels, training investment, criticality to the defense mission, etc., determine the need for an SRB for an MOS.

c. Existing data to allow an analysis of the relationship between SRBs and reenlistments is available and sufficient.

d. The cost factors in the Military Occupational Specialty Training Cost Handbook are valid for training cost data.

e. The MILPERCEN methodology for projecting personnel shortfalls by MOS is valid.

f. The MILPERCEN reenlistment forecast methodology is an acceptable tool for projecting reenlistment data.

g. The Army will continue to pay SRBs.

h. The funds available to pay SRBs will remain constrained.

i. A peacetime environment will continue.

1-7. ESSENTIAL ELEMENTS OF ANALYSIS (EEA). As stated in the study directive, the EEA are:

a. What effect have SRBs had on reenlistment rates?

b. What influence have exogenous variables (unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio) had on bonus induced reenlistment rates?

c. What are the most important selection criteria to consider when selecting an MOS for the SRB Program?

d. What kind and frequency of analysis must be performed to effectively allocate SRB funds?

e. What kinds of data will be needed to use the proposed SRB methodology?

f. What data not currently available must be gathered so that the proposed methodology can be implemented? What time span should the data cover?

1-8. CONTENTS OF THE REPORT. The chapters that follow, supported by appendices, present the results of the SRB Study. Chapter 2 discusses the manner in which the study was conducted. The description of the SRB Program is covered in Chapter 3. In Chapters 4, 5, and 6, the development and analysis of SRB effectiveness, criticality selection criteria, and allocation methodologies, respectively, are described. The final chapter presents a summary of the study and resulting observations.

CHAPTER 2

STUDY METHODOLOGY

2-1. INTRODUCTION. This chapter describes the methodology employed and the general tasks performed during the conduct of the Selective Reenlistment Bonus (SRB) Study. Figure 2-1 depicts the four-phase approach used, from background gathering, through development of methodologies and models, to application of methodologies and models developed, and culminating in evaluation and report publication.

2-2. METHODOLOGY OF THE STUDY. The background phase provided the study team with a working knowledge of SRB Program policies and procedures, available data, existing models and methodologies, and tools and techniques for model and methodology development. During the development phase, relevant data were selected, tools and techniques were used to manipulate the data, and effectiveness, criticality selection criteria and allocation methodologies and models were developed. In the application phase, test data were run through the models to ensure the workability of the models and the validity of the methodologies that had been developed. During the evaluation phase, output from the models was analyzed and adjustments were made to fine tune the models and methodologies. Although Figure 2-1 depicts the phases as occurring sequentially, in reality, there was considerable overlap. The collection of data was continuous throughout the study period and the test and evaluation of the effectiveness methodology and model were initiated and completed prior to completion of the allocation methodology and model. The preparation of the report extended over the period of the study. The following describes in more detail the work accomplished in each phase of study.

a. Background Phase. The purpose of this phase was to acquire a working knowledge of SRB Program policies and procedures, to collect pertinent data, to review existing models and methodologies, and to select tools and techniques for use in the study.

(1) The first task of this phase was accomplished through a search of the literature relevant to the SRB Program. A detailed examination of the current regulatory guidance and a review of reports by other analytic agencies provided a basic knowledge which was augmented by interviews with personnel that were knowledgeable in SRB Program policies and procedures. Using this information, the SRB study team described the SRB Program in detail, covering the following areas: historical development, current program policies and procedures, award experience, and management structure and responsibilities.

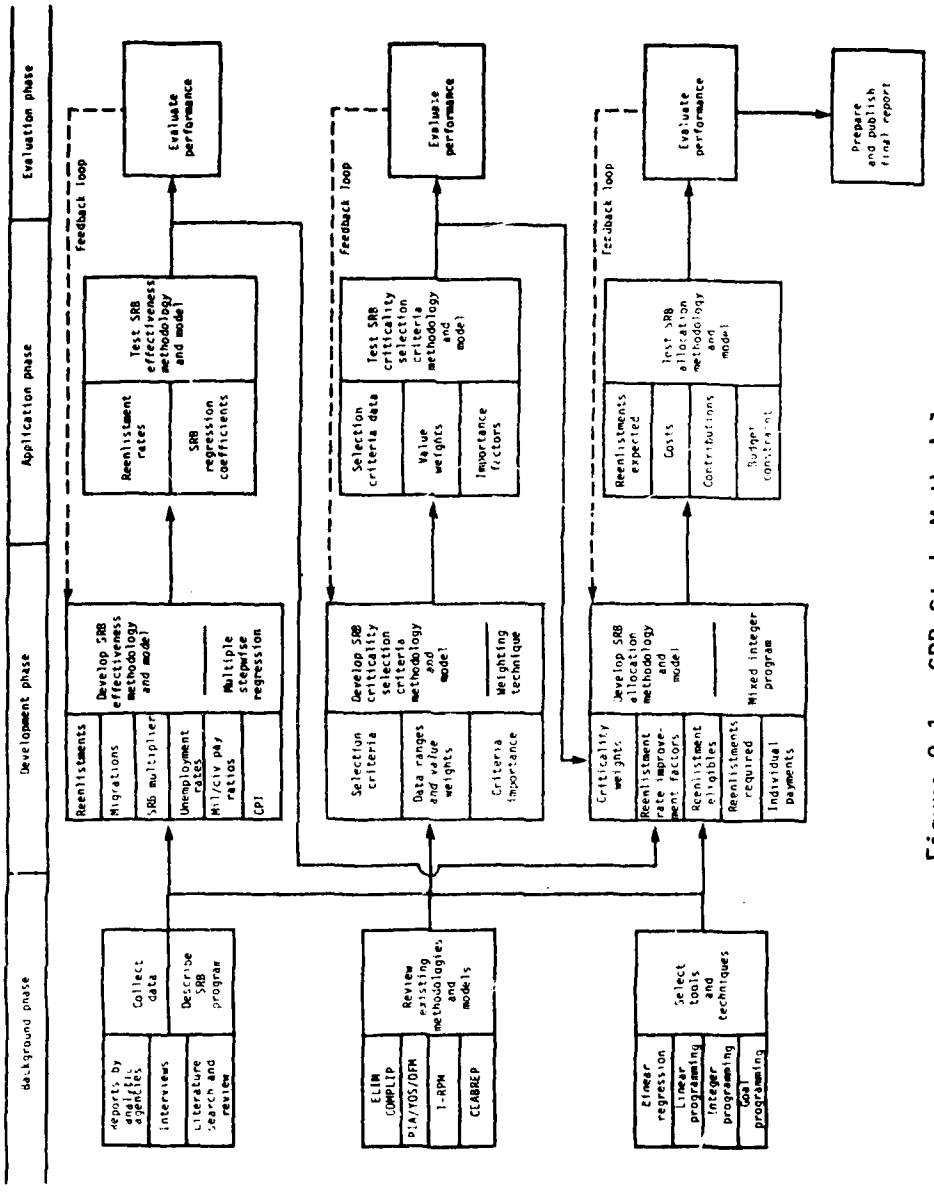

Figure 2-1. SRB Study Methodology

(2) The second task of the background phase was to collect data and to determine its relevancy to the study. Army endogenous data consisted of military occupational specialties (MOS) that had received SRBs since the program's inception, the size of the SRB award (SRB multipliers), reenlistment rates, and reenlistment migration rates from the MOSs over the same time period. In addition, data on Regular Military Compensation (RMC), MOS training costs, and SRB payments were gathered. Exogenous data collected were occupational unemployment rates, civilian earnings and the Consumer Price Index (CPI).

(3) The third task was to determine what Army personnel models and methodologies were in use, their output and relationship to this study. This task was accomplished by examining model descriptions and published reports on methodologies that had been developed. These included the Enlisted Loss Inventory Model - Computation of Manpower Programs Using Linear Programming (ELIM-COMPLIP), Personnel Inventory Analysis/Year of Service/Objective Force Model (PIA/YOS/OFM), First Term Reenlistment Projection by Military Occupational Specialty (1-RPM) methodology, and the Cost Effectiveness Analysis of Bonuses and Reenlistment Policies (CEABREP) System.

(4) The last task was to select analytic tools and techniques for use in the study. The effort focused on analytic tools and techniques that could be used in analyzing the past effectiveness of SRBs in inducing reenlistments and the allocating of SRB funds. It was determined that multiple stepwise regression was the best means of analyzing effectiveness. For the allocating of SRB funds, the search led to an evaluation of linear, goal and integer programing. It was determined that the Mixed Integer Program of the Functional Mathematical Programming System (MIP-FMPS) provided the desired features and flexibility for allocating SRB funds.

b. Development Phase. This phase provided for the concurrent development of an SRB effectiveness methodology/model, an SRB criticality selection criteria methodology/model, and an SRB allocation methodology/model.

(1) The SRB effectiveness methodology was developed through the completion of three tasks. The first task was to automate the historical endogenous data (reenlistments, migrations and associated SRB multipliers) and exogenous data (unemployment rate, military pay/civilian pay ratio and CPI). This task was accomplished by obtaining computer tapes from the US Army Military Personnel Center (MILPERCEN) for the endogenous data and from the Bureau of Labor Statistics (BLS) for unemployment data. The remaining exogenous data was extracted from printed reports and automated. The second task was to perform an analysis of the data. This task was completed through a multiple stepwise regression analysis of the historical data at MOS, career management field (CMF) and skill group levels. The final task was to develop improvement factors. To do this, the SRB regression coefficients resulting from the skill group

analysis were applied to reenlistment rates adjusted for migration to produce reenlistment rate improvement factors for all MOS/zones. These factors were used as input to the allocation methodology.

(2) The SRB criticality selection criteria methodology was developed by completing two tasks. The first task was to identify the criteria that are important in determining if an MOS should receive an SRB. This was done by using as a basis the SRB selection criteria contained in Department of Defense (DOD) Instruction 1304.22. In coordination with the Office of the Deputy Chief of Staff for Personnel (ODCSPER) and the MILPERCEN, nine criteria were identified as being most important in determining whether an MOS should receive an SRB award. The second task was to quantify these criteria. This was accomplished by assigning data ranges and value weights to each criterion and developing the relative importance of each criterion in determining whether or not an MOS should receive an SRB. Input data for the criteria were automated and, using a weighting technique, criticality weights were computed for all MOS/zones. The criticality weights produced were used as input to the allocation methodology.

(3) The SRB allocation methodology involves two principal tasks. The first task was to determine the data required and to automate the data. This task was accomplished by using as input the reenlistment rate improvement factors produced by the effectiveness methodology and the criticality weights from the criticality selection criteria methodolgy as well as by obtaining automated data on reenlistments required, reenlistment eligibles, and individual payments from MILPERCEN. The last task was to allocate constrained SRB funds to MOS/zones in the most cost effective manner. This was done by using the above data and projecting the number of reenlistments, by multiplier, for each MOS/zone, as well as the costs and criticality weight points associated with the reenlistments by multiplier. The costs and criticality weight points for all MOS/zones were then used in the MIP-FMPS which made tradeoffs between these two entities and found the optimal allocation of funds within the established budget constraint. For every MOS/zone, the output produced consisted of the SRB multiplier assigned, the reenlistments associated with that multiplier, and the cost and criticality weight points associated with those reenlistments.

c. Application Phase. During the application phase, the methodologies/models that had been developed were tested by using data that MILPERCEN had used in making its FY 82 allocation that was submitted to DOD in May 81.

(1) The data used for the FY 82 SRB budget allocation projected by MILPERCEN in May 81 was selected to test the methodologies as it was the most current and still automated. The MILPERCEN projection was based on data available to them as of the end of FY 80. Consequently, the data used to test the methodologies developed was also that of FY 80.

(2) The reenlistment rate improvement factors for each MOS/zone were derived by using the FY 80 reenlistment rate, adjusted for migration, as a base and adding to or subtracting from it the associated SRB regression coefficient that had resulted from the regression analysis.

(3) The criticality weights for each MOS/zone were computed using FY 80 data of each MOS/zone for the nine selection criteria identified as being most important in determining whether an MOS should receive an SRB. The input data was converted to value weights, based upon the data range in which it fell, then multiplied by an importance factor for each criterion to produce a category weight. A criticality weight for each MOS/zone was produced by taking the average of the nine category weights.

(4) The allocation methodology used MILPERCEN FY 82 projections for reenlistments required and reenlistment eligibles for each MOS/zone. The individual payment table used to calculate SRB costs was the same one used by MILPERCEN in its budget preparation. The table used was based on the FY 81 pay scale, an average monthly basic pay for each zone, and an assumed reenlistment of five years. The budget constraint used was the amount of funds that MILPERCEN had allocated in May 81 for the FY 82 SRB Program. Reenlistment rate improvement factors and the criticality weights from the effectiveness and criticality selection criteria methodologies were also inputs.

d. Evaluation Phase. In this phase, the methodologies/models were evaluated and adjustments made as required to ensure their validity and workability. The SRB study allocation results were evaluated through a comparison with the allocation made by MILPERCEN in May 81 in the areas of multipliers assigned, reenlistments obtained, SRB costs and contributions for all MOS/zones. The performance of the SRB study allocation with various budget constraints was also evaluated. In addition, the final report, which was drafted and refined as the four phases were performed, was finalized and published.

2-3. ANALYTIC TOOLS AND TECHNIQUES. The tools and techniques employed in the SRB Study are as depicted in Figure 2-1 and as mentioned in paragraph 2-2. Program routines and input and output data bases have been placed on computer tape as well as on printouts and have been provided to MILPERCEN for their use. A description of each model, to include a flowchart, model logic, and input and output requirements, is provided in Appendix D.

2-4. QUALITY ASSURANCE. Quality assurance of the study product was achieved through continuous coordination with knowledgeable and experienced personnel at MILPERCEN and in ODCSPER, Headquarters, Department of the Army. As concepts were developed and data analyzed during the study, discussions were held with appropriate points of contact to ensure accuracy, consistency, and compliance with current policies and procedures. Technical assistance was obtained from the

Mathematics/Statistics Team, Methodology and Computer Support Directorate of the US Army Concepts Analysis Agency (CAA) in the statistical analysis of SRB effectivenss. In-process review briefings were provided to the CAA Analysis Review Board (ARB) and to the Study Advisory Group (SAG) to ensure utilization of sound techniques and study procedures, and compliance with the study directive. In addition, the CAA Product Review Board (PRB) reviewed the study prior to publication.

CHAPTER 3

SELECTIVE REENLISTMENT BONUS (SRB) PROGRAM

3-1. INTRODUCTION. This chapter traces the historical development of the SRB Program and summarizes the current program. Reenlistment zones of eligibility, SRB calculation, soldier eligibility, and MOS selection criteria are discussed. Historical data for the SRB Program is presented. In addition, current SRB procedures are reviewed and the management structure described.

3-2. HISTORICAL PERSPECTIVE. Throughout its history, the Army has experienced problems in retaining soldiers beyond their initial term of service. This has been very costly in that their training costs have for the most part resulted in only a few years of active service. In this regard, the Army has paid reenlistment bonuses to soldiers as financial incentives to retain them beyond their initial enlistments. Prior to 1966, a regular reenlistment bonus (RRB) was paid to all soldiers who reenlisted regardless of their military occupational specialty (MOS). In addition, shortage specialty proficiency pay (SSPP) was paid to all soldiers in designated MOSs that were short personnel. Beginning in January 1966, Congress authorized, in addition to the RRB and SSPP, the payment of variable reenlistment bonuses (VRB) for reenlistments in MOSs that were not retaining sufficient numbers of soldiers. Thus, starting in January 1966, there were three pay incentives being used to improve first-term reenlistments.

a. Regular Reenlistment Bonus. The RRB was paid to all soldiers who reenlisted. The bonus payment was a lump sum payment at the time of reenlistment which amounted to one month's basic pay for each year the soldier reenlisted; however, the payments could not total more than $2,000 during a career.

b. Shortage Specialty Proficiency Pay. The SSPP was paid to all career personnel (those beyond their first term of enlistment) in designated shortage MOSs. The bonus was a specified amount ($50, $100, or $150) paid monthly as long as the MOS was so designated.

c. Variable Reenlistment Bonus. The VRB was paid to soldiers who reenlisted in designated MOSs that were experiencing low retention levels. The amount paid was determined by multiplying the RRB amount authorized by a selected multiplier (1, 2, 3, or 4) according to the perceived need. The payment was made in either a lump sum at the time of reenlistment or in annual installments on the reenlistment anniversary over the period of that reenlistment.

3-3. CURRENT SRB PROGRAM. In order to streamline and increase the flexibility of reenlistment bonus incentive programs, Congress passed Public Law 93-277, The Armed Forces Enlisted Personnel Bonus Revision

Act, which became effective 1 June 1974. The Act established the SRB Program and terminated the RRB and VRB Programs. The Act was implemented by the Department of Defense (DOD) through the issuance of DOD Directive 1304.21, Award of Enlisted Personnel Bonuses and Proficiency Pay, and DOD Instruction 1304.22, Administration of Enlisted Personnel Bonus and Proficiency Pay Programs. The Army, in turn, prescribed policies and provided instructions on the administration of the SRB Program via Army Regulation (AR) 600-200, Enlisted Personnel Management System. A summary of the Army's current SRB Program is as follows:

a. Reenlistment Zones of Eligibility. A selective reenlistment bonus is paid to a soldier who is serving in and reenlists in that designated MOS which is experiencing retention levels insufficient to sustain the career force. The SRB Program has three reenlistment zones of eligibility established for management purposes. These periods generally encompass the first, second, and third reenlistment decision points. Historical reenlistment rates for the different zones also vary considerably.

(1) Zone A - reenlistments that occur between 21 months and 6 years of active service.

(2) Zone B - reenlistments that occur between 6 and 10 years of active service.

(3) Zone C - reenlistments that occur between 10 and 14 years of active service.

b. Amount of SRB. The amount of the SRB is calculated by multiplying the soldier's monthly basic pay, by the number of years (or fractions thereof) of additional obligated service (not to exceed 6 years), by a selected SRB multiplier (1 through 6). The SRB cannot exceed $16,000 and is normally a lump sum payment of 50 percent of the bonus at the time of reenlistment with the other 50 percent made in equal annual installments on the anniversaries of the reenlistment. In addition, a soldier can be paid an SRB only once in each reenlistment zone of eligibility.

c. Eligibility Criteria. A soldier, in order to be eligible for an SRB, must be serving on active duty in the grade of E-3 or higher. The individual must also be qualified in a primary MOS (PMOS) which has been designated for award of the SRB and reenlist in that PMOS in the Regular Army for at least 3 years. The requirement to be qualified in a PMOS is waived for those soldiers participating in the Bonus Extension and Retraining (BEAR) Program. The BEAR Program allows eligible soldiers an opportunity to extend their current enlistment for formal retraining in an MOS receiving an SRB and, upon completion of retraining, be awarded the new PMOS, reenlist, and receive an SRB in the newly awarded PMOS.

d. MOS Designation for SRB. The currently published criteria and guidelines to be used to designate which MOS is to receive an award of an SRB and the appropriate multiplier to be used within each zone of eligibility are as follows:

(1) The previous and projected shortfalls in reenlistment objectives in the MOS are to be determined by comparing the number of reenlistees required in year groupings (reenlistment zones of eligibility) with the actual and projected numbers of reenlistees in year groupings necessary to sustain the career inventory in the MOS. The career manning shortage in the MOS is to be determined by comparing the requirements for career personnel in an MOS with the inventory. The MOS should not be achieving its reenlistment objective or be seriously undermanned in three or more career years or have chronic shortages in the career inventory.

(2) The training investment in the MOS is to be based on the cost of formal school training to qualify first-term personnel in an MOS. The MOS should have a high training investment.

(3) The retention improvement expected in the number of additional personnel gained in the MOS for an SRB award is to be estimated through the use of estimating factors that project the improvement in reenlistment rates for each multiplier of an SRB award. The expected retention improvement response in the MOS from the award of an SRB should be sufficient to justify the SRB expenditure.

(4) The priority of the MOS is to be determined by its essentiality in accomplishing the Army's mission.

(5) The unattractiveness of the MOS, and any other considerations that may be relevant.

3-4. PAYMENTS. Historical data as well as projections for future years that reflect the number of SRB payments and the total dollar amount were obtained from the US Army Military Personnel Center (MILPERCEN).

a. Payment Experience. Since the inception of the SRB Program in fiscal year (FY) 75, the number and amount of new payments made are as depicted in Table 3-1. New payments are the payments made at the time of reenlistment and do not include any obligated installment payments disbursed on the anniversary date of the reenlistment. Over the history of the program, the number and amount of new payments have fluctuated considerably.

Table 3-1. SRB Program New Payments, FY 75 - FY 81

FY	Number	Amount ($ million)
75	15,516	133.1
76	8,762	46.2
76T	2,136	11.1
77	11,510	59.3
78	16,380	65.8
79	14,892	57.5
80	15,367	63.5
81	21,910	120.3

b. Projected Payments. The SRB Program new payments over the program years are projected to grow as shown in Table 3-2. The program is expected to peak in FY 86 with the number of new payments increasing by 52 percent and the dollar amount increasing by 112 percent from FY 81.

Table 3-2. Projected SRB Program New Payments, FY 82 - FY 87

FY	Number	Amount ($ million)
82	21,389	149.8
83	27,838	216.8
84	31,343	234.4
85	32,712	249.4
86	33,344	254.8
87	32,687	249.2

3-5. SRB AWARD EXPERIENCE. The amount of an SRB is a function of the MOS authorized, the three reenlistment eligibility zones, and the six SRB multipliers. The data below indicate both the current number of MOSs receiving SRBs, by respective zones and multipliers, and experience of prior years.

a. Current Data. There were 112 MOSs receiving SRBs in one or more reenlistment zones of eligibility as of 15 February 1982. This is approximately 34 percent of all MOSs. There are 23 Career Management Fields (CMF) that have MOSs with SRBs. This represents 77 percent of the CMFs. The breakout by zone and multiplier are shown in Table 3-3.

Table 3-3. Number of SRBs Paid (15 Feb 82)

Zone	Multiplier						Total
	1	2	3	4	5	6	
A	40	39	4	9	5	0	97
B	49	32	4	3	4	0	92
C	10	6	0	2	0	0	18
Total	99	77	8	14	9	0	207
(Represents 112 MOSs or 34% of all MOSs)							

b. Historical Data. This same information, as of the end of each FY, over the life of the SRB Program, is graphically depicted in Figure 3-1. The number of MOSs receiving SRBs has ranged from a low of 25 percent to a high of 45 percent of all MOSs. A Zone C bonus was first authorized for payment in FY 81 because it appeared that there were insufficient reenlistments in the 10-14 years of service (YOS) category to adequately man the career force. Although a multiplier 6 has been authorized since the program's inception, it has never been used.

3-6. REVIEW OF CURRENT SRB PROCEDURES. A review was made by the study team of current procedures used to designate MOSs to receive SRBs and to select the appropriate award multipliers. This review provided the basis for the methodology developed in this study and resulted in the following observations:

a. Selection Criteria. Criteria to be used to determine which MOSs are to receive SRBs as specified in DOD Instruction 1304.22 are for the most part ambiguous and generally unquantified, e.g., essential to accomplishment of defense mission. Criteria necessary to determine the criticality of MOSs to receive SRBs should be identified and quantified as far as possible.

b. MOS Priorities. No method exists for prioritizing MOSs for receipt of SRBs. A formal weighting system should be developed using the identified criticality selection criteria to determine each MOS's priority to receive an SRB.

c. Improvement Factors. Estimating factors used to determine the improvement in reenlistment rates from awards of SRBs are overall Army factors and are applied to all MOSs equally. The development of improvement factors for each MOS (based on historical SRB data) should be addressed since it is likely that not all MOSs are equally affected by an SRB award.

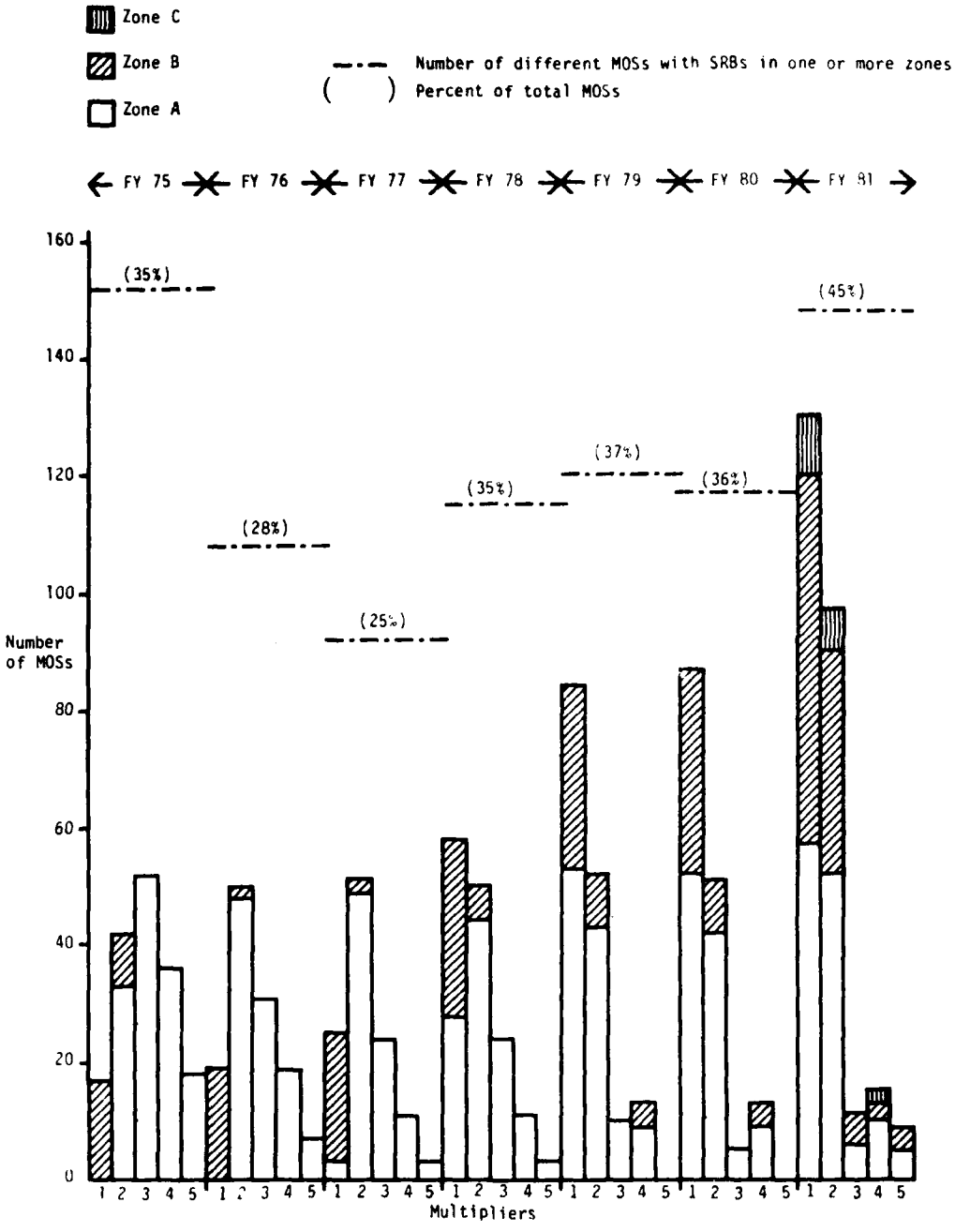

Figure 3-1 Number of MOSs Receiving SRBs, FY 75 - FY 81

d. Cost Effectiveness. The increased number of reenlistments expected in an MOS from an award of an SRB in relation to the cost of the SRB are not systematically compared with other MOSs to determine the most cost effective allocation of budgeted funds among all MOSs.

e. Formal Procedures. Formal standard procedures have not been developed to determine the MOSs to receive SRBs. Decisions are largely subjective as to which MOSs receive them. A formal standardized methodology should be developed so that MOSs to receive SRBs can be objectively designated and the SRB funds for these MOSs can be effectively allocated.

f. Implementation. The data necessary to effectively manage the SRB Program is voluminous. Therefore, the methodology developed should be automated.

3-7. MANAGEMENT OF THE SRB PROGRAM. The management structure and responsibilities of those organizations involved in planning, directing, and implementing the SRB Program are as follows:

a. The Deputy Chief of Staff for Personnel (DCSPER) has primary Department of the Army (DA) staff responsibility for the SRB Program and, in this regard, establisnes policies and exercises overall management and direction of the program.

b. The Commander, US Army Military Personnel Center (MILPERCEN) develops and issues policies, standards, and procedures; provides technical supervision; and administers the SRB Program. Specifically, MILPERCEN designates MOSs to receive SRBs and the appropriate award multiplier for each zone of an MOS; budgets Military Personnel Army (MPA) funds for the payment of SRBs; monitors the use of SRB recipients; and is the proponent for AR 600-200, Enlisted Personnel Management System, and DA Circular 611-73, Announcement of Proficiency Pay/Selective Reenlistment Bonus/Enlistment Bonus/Career Progression MOS/Comparable MOS for Bonus Recipients.

c. The Commander, US Army Finance and Accounting Center (USAFAC) is responsible for the financial administration of the SRB Program to include payment processing in accordance with AR 37-104-3, Military Pay Allowance Procedures - Joint Uniform Military Pay System (JUMPS-Army); and recoupment of unearned portions of SRBs from recipients.

d. Commanders at all echelons are responsible for supervision and administration of the SRB Program at their respective commands to include familiarization of soldiers with the program, identification of eligible persons, preparation of personnel and financial records and reports, and proper utilization of personnel receiving SRBs.

3-8. SUMMARY. Historically, the Army has used bonuses as incentives to retain personnel. Current procedures used to designate MOSs to receive SRBs and to select award multipliers are informal, manual in nature, rely on largely subjective decisions, and do not necessarily make the most effective allocation of SRB funds. Current procedures appear to be inadequate for a program marked to grow to approximately $250 million by FY 85.

CHAPTER 4

SRB EFFECTIVENESS METHODOLOGY

4-1. INTRODUCTION

a. The Army has used the selective reenlistment bonus (SRB) to induce enlisted personnel to reenlist in selected military occupational specialties (MOS) since June 1974. The continued use of the SRB over the last 8 1/2 years suggests that the SRB does have an impact on reenlistment decisions and its use is supported by the literature. A RAND study (Reenlistment Bonuses and First-term Retention; Sep 77) investigated the effects of the SRB on first-term reenlistments by service (Army, Air Force, and Navy) using data for fiscal years 74 and 75. This study concluded that the bonus was an effective inducement for reenlistments, but found no evidence of significant difference in the way military personnel with different skills responded to the bonus. It developed aggregate effectiveness factors for each of the three services and recommended the use of the Army factors throughout the Department of Defense (DOD) A more recent study by the Navy (Rehab Group, Inc., The Impact of Selective Reenlistment Bonuses upon First- and Second-term Retention; Jul 80) found some evidence that different skills respond differently to the bonus. This study categorized Navy personnel into three groups depending upon whether the skill's response to the bonus was *high, medium, or low.*

b. The Army's SRB Program totaled $120 million in FY 81 and it is projected to increase in FY 82. Effective management of this program requires valid measures of the SRB effect if program funds are to be allocated in an optimal fashion. Currently, management of the program is based on effectiveness measures developed in the RAND study. Data used in that study are now 6 1/2 years old. This 6 1/2-year period has witnessed significant changes such as a more positive perception of military service, significant increases in military pay, and record high Army reenlistment rates. Factors such as these underscored the need to reexamine the bonus effectiveness issue for Army personnel with a more recent data base.

c. The remainder of this chapter presents the methodology that was used to quantify the effect of the SRB on reenlistments from a historical perspective. The chapter describes the input data, the development of a statistical model and its application, and it concludes with the results of the analysis and major observations.

4-2. EFFECTIVENESS METHODOLOGY OVERVIEW. An overview of the methodology to determine the historical effect that SRB payments have had on reenlistments is shown in Figure 4-1. The key output of the methodology

is a quantitative measure of past SRB effectiveness at the skill level of detail. These measures are suitable for use in the automated management of the SRB Program. Discussion of the methodology in terms of its inputs, statistical analysis, and outputs follows.

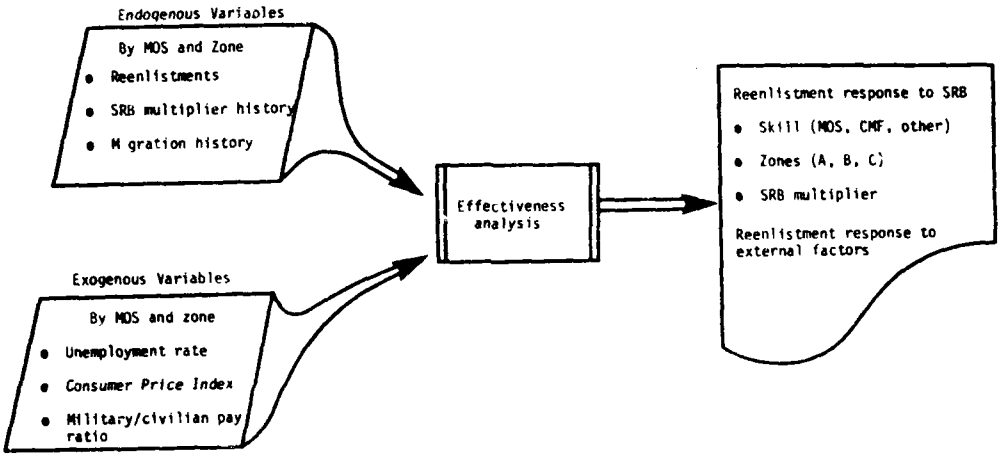

Figure 4-1. Overview of SRB Effectiveness Methodology

a. Inputs. A key assumption of the methodology is that many factors influence the soldier's decision to reenlist or not to reenlist. Therefore, to the extent that one can reliably quantify factors other than the bonus that influence this decision, the estimate of the SRB's effect will be improved because those other factors will have been specifically provided for. For this reason, the methodology considers the effect of influences external to the Army (exogenous variables) as well as those Army variables (endogenous variables) which are thought to be relevant to the analysis.

(1) Endogenous. Historical reenlistment rates and SRB multipliers were necessary endogenous variables, since the purpose of the analysis was to determine the effect of bonus payments on reenlistments. A third Army variable, migration history, was added because some MOSs that receive bonuses also experience high migration from the MOS. The purpose of the bonus is to induce reenlistments in an MOS with definite needs. Migration from an MOS that is receiving a bonus indicates that the bonus is not sufficient inducement to those who leave, because they are generally ineligible for a bonus in the gaining MOS. An exception is the Bonus Extension and Retraining (BEAR) Program participant as discussed in Chapter 3, paragraph 3-3c. Therefore, migration experience was applied to Army reenlistment rates to determine the effective reenlistment rates in the MOS. Paragraph 4-3b presents detailed discussion of each of the endogenous variables and data sources.

(2) Exogenous. It is reasonable to assume that the soldier's reenlistment decision may be influenced by some factors other than the SRB, such as (a) likelihood of finding work as a civilian (unemployment rate for skill), (b) overall economic outlook (Consumer Price Index), and (c) the likelihood of making more money as a civilian performing a similar job (military/civilian pay ratio). Further discussion of each of the exogenous variables and their sources is contained in paragraph 4-3c.

b. Analysis and Outputs. Multiple regression analysis was used to explain the relationship between the input variables discussed above. The regression model was designed to evaluate differences in bonus response by job characteristics, reenlistment zones of eligibility, and size of the bonus payment (as measured by the bonus multiplier). Paragraphs 4-4 and 4-5 provide more detail on the regression formulation and the result of its application. The most important outputs of the regression model are the regression coefficients for the SRB multiplier variable. These coefficients are measures of the change in reenlistment rates associated with a change in multiplier level. The use of these outputs in the allocation of SRB funds is discussed in paragraph 4-6 and Chapter 6, paragraph 6-4.

4-3. DATA BASE. This paragraph discusses the data base used in the SRB effectiveness analysis. It addresses the historical period covered and further elaborates on the types of data inputs.

a. Historical Period and Sampling Frequency. The historical data base for this analysis covers quarterly observations from January 1976 to June 1981. The SRB Program began in June 1974; however, the first year and a half of data was excluded on the premise that these data might reflect irregularities associated with the beginning of any new system.

b. Endogenous Variables. As discussed in paragraph 4-2a(1), historical data on three Army variables were utilized in this analysis. Detailed discussion of each of these variables follows.

(1) Reenlistment Data. Department of the Army Personnel Center Report 120 (DAPC-120) is the source document for reenlistment data used in this study. For each MOS, the report provides the number of separations that are eligible to reenlist, the number that reenlist, and the reenlistment rate by years of service. Years of service provides a crosswalk to reenlistment zones of eligibility as discussed in Chapter 3, paragraph 3-3a. Since a soldier must separate in order to reenlist, the term separation will be used interchangeably with eligibles. The reenlistment rate is the ratio of those who reenlist to those eligible to reenlist. The DAPC-120 reports are published to reflect monthly, quarterly, and annual data. Automated versions of the reports are maintained by the US Army Military Personnel Center (MILPERCEN) for only about 200 days. Consequently, for this study, MILPERCEN recreated an automated source of the DAPC-120 reports dating back to 1976. The MOS-based retention history was recreated using quarterly observations due to MILPERCEN's assessment that recomputation of monthly data would have required too much time and computer resources.

(2) Historical SRB Multiplier. As discussed in Chapter 3, historical SRB payments represent multiples of a soldier's monthly basic pay and additional years of obligated service--hence the term SRB multiplier. Possible SRB multiples range from 0 to 6, with a 0 multiplier representing no bonus payment, while a multiplier of 6 represents six times the individual's monthly basic pay and additional years. The SRB multiplier 6 has never been assigned to an Army skill due to the present limitation of $16,000 on SRB payments as discussed in Chapter 3. Figure 4-2 shows the distribution of MOSs receiving SRBs by career management field (CMF) in Zone A during the period studied. Ninety percent of the CMFs (28 out of 30) received a bonus at some time during this period. The 28 CMFs represent 175 MOSs receiving a bonus, 50 percent of which comes from just 6 CMFs. The medical field (CMF 91) had the largest number of MOSs (21) receiving a bonus. Table 4-1 shows the Zone A bonus multipliers that were assigned to each of the 21 medical MOSs during this period. For example, Medical Specialists (91B) received multiplier 2 from first quarter 76 through first quarter 79, and multiplier 1 from second quarter 79 until second quarter 81. Data similar to that in Table 4-2 were acquired and processed for each MOS and career management field in all three zones. In Zone B, 120 MOSs representing 23 CMFs received bonuses. The distribution of Zone B MOSs receiving a bonus by CMF is summarized in Figure 4-3. Approximately 50 percent of the MOSs came from five CMFs and the medical field again had the most MOSs (18) receiving a bonus. Figure 4-4 summarizes similar data for Zone C where 11 MOSs representing six CMFs received bonuses. Military Intelligence (CMF 96) and Electronic Warfare (EW)/Cryptologic Operations (98) each had three MOSs that received bonuses in Zone C.

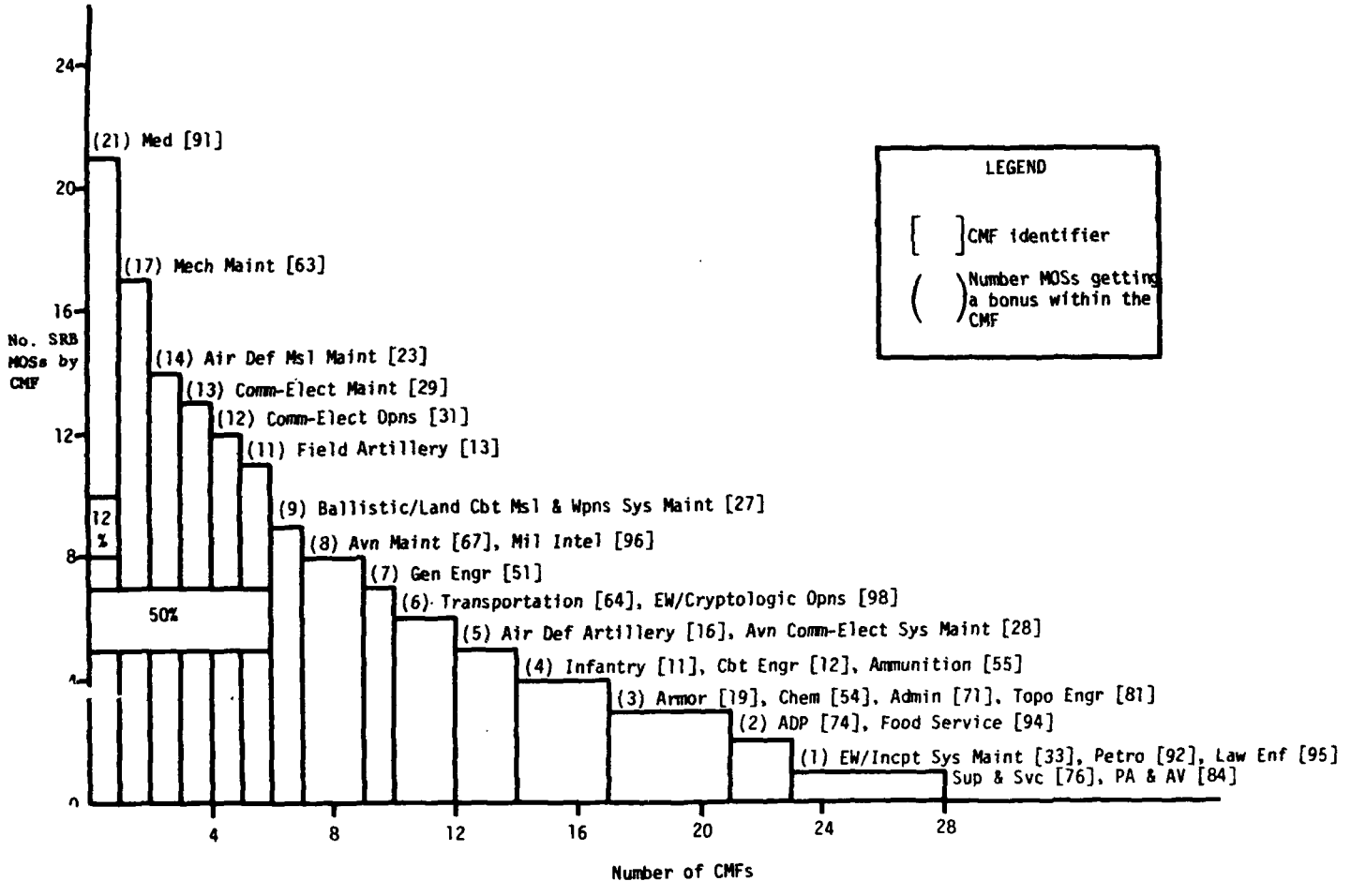

Figure 4-2. Distribution of Zone A MOSs that Received an SRB by CMF

Table 4-1. SRB Multipliers for Medical Career Management Field (91) by MOS and Quarter in Zone A

MOS title	MOS code	1976				1977				1978				1979				1980				1981			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Biomed Eq Maint Chief	35U																				1	1	1		
Dental Lab Spec	42D												1	1	1	1									
Medical Spec	91B	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1		
Patient Care Spec	91C	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1		
Operating Rm Spec	91D	3	3	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	1	1	1		
Dental Spec	91E	2	2																						
Psychiatric Spec	91F	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Beh Science Spec	91G	3	3								3	3	3	3	3	3	3	3	3	3	1	1	1		
Orthopedic Spec	91H	3	3	2	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1		
Phy Therapy Spec	91J																				1	1	1		
Occup Therapy Spec	91L	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2					
Cardiac Spec	91N	2	2																						
X-ray Spec	91P	3	3																						
Pharmacy Spec	91Q	4	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	1	1	1		
Veterinary Spec	91R	3	3	3	3	3	3	3	3	3	3	3									1	1	1		
Environ Health Spec	91S	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1		
ENT Spec	91U	2	2	2	2																1	1			
Respiratory Spec	91V								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
Nuclear Med Spec	91W																				2	2	2		
Med Lab Spec	92B	3	3	3	3	3	3	3	2	2	2	2													
Biol Sci Asst	01H								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		

NOTE: Absence of a multiplier in a given quarter means that the MOS did not receive a bonus during that period.

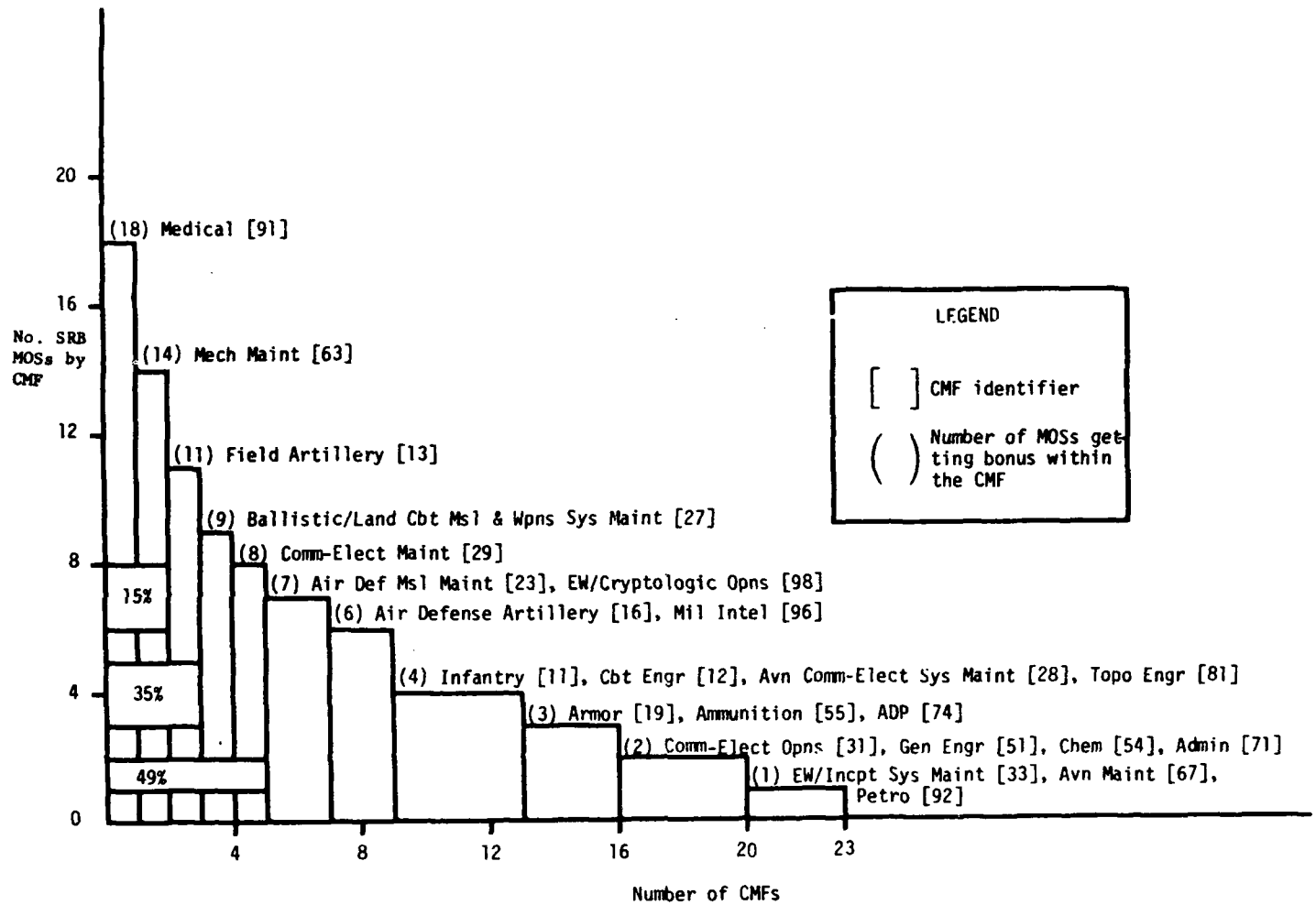

Figure 4-3. Distribution of Zone B MOSs that Received an SRB by CMF

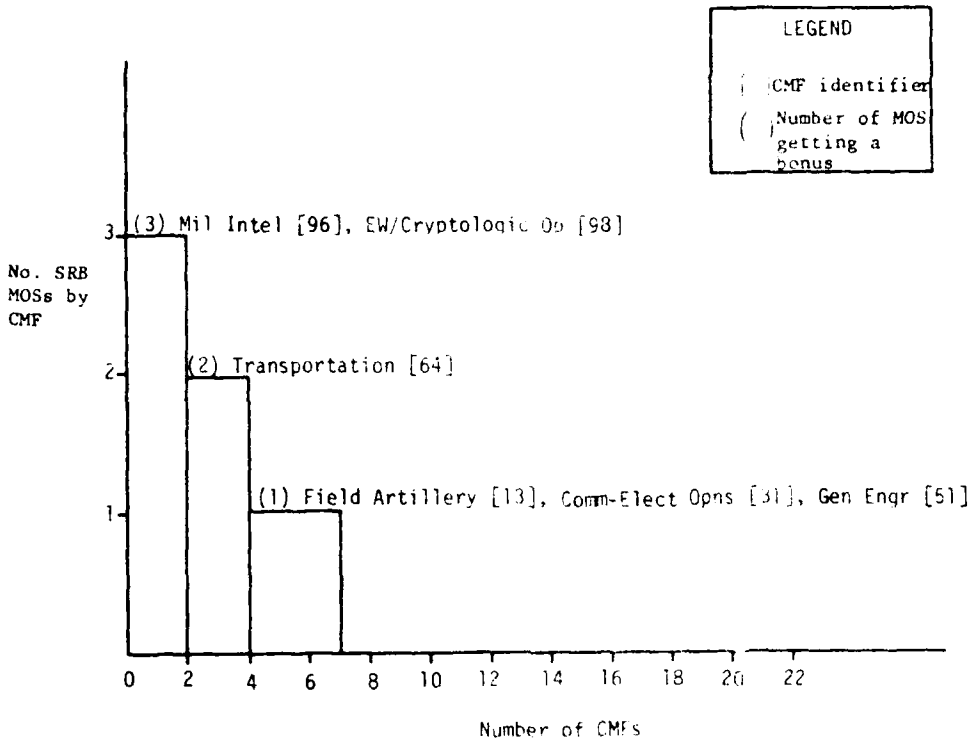

Figure 4-4. Distribution of Zone C MOSs that Received an SRB by CMF

(3) Migration. Migration patterns out of an MOS were of concern since personnel who migrate into an MOS are generally ineligible for bonus payments (exceptions are BEAR participants). The source of migration data was the MILPERCEN Year Group Management Program (GYMPY) data file. The GYMPY file provided for each quarter the total verified reenlistments for each MOS, number of reenlistments for the same MOS, and number of reenlistments for a different MOS. Table 4-2 illustrates the migration data for MOS 11B and its use. While the GYMPY file was the best source of migration data available, it only contained data since 1979, and extensions were erroneously classified as reenlistments in some cases. Because of the absence of migration experience prior to January 1979, an average migration rate was computed for the 2 1/2 years of history (column d) and used to adjust the unadjusted Army reenlistment rates (column g) to an effective reenlistment rate for the MOS (column h). To overcome the classification problem, the migration data used here included only those records that could be verified as reenlistments (column a). By excluding all records that could not be verified, some records were probably excluded that were, in fact, reenlistments. This explains why total reenlistments from GYMPY (column a) were less than total reenlistments from DAPC-120 Report (column f).

d. Data Integration. Endogenous and exogenous variables were integrated as illustrated in Figure 4-5 to form the base case data set to be analyzed. Details of the automated processing necessary to integrate these data are presented in paragraph D-2 of Appendix D. Figure 4-5 illustrates the data elements of the data set using MOS 11B experience during the first and second quarters of FY 76. The data set provides data for each of the six inputs, i.e., reenlistment rates, SRB multipliers, migration rates, unemployment rates, military to civilian pay ratio, and the Consumer Price Index. The pay ratio element lacks data in the example since 11B was one of those skills for which earnings data were not available, as discussed in paragraph 4-3c(3). The integrated data set also provides skill (MOS and CMF) and zone identification. A scatter plot of Zone A integrated data for Infantrymen (11B) is shown in Figure 4-6. This plot provides historical trends of reenlistment rates at various SRB multipliers, CPI data, and unemployment data. Data for the MP/CP ratio was unavailable. As indicated in the graph, reenlistment rates for individual MOSs generally increased during this period, even when the SRB multiplier decreased. This phenomenon occurred in most of the military skills and was a major consideration in the type model selected to analyze the data. Paragraph 4-4a(4) discusses the statistical model in more detail. Figures 4-7 and 4-8 depict the integrated data for MOS 11B in Zones B and C, respectively. The trends between zones for MOS 11B are fairly representative of the entire data base in that reenlistment rates were generally higher and more stable for increasing years of service.

Table 4-2. Migration Data and Reenlistment Data Integration, MOS 11B

	(a)	(b)	(c)	(d)[a]	(e)	(f)	(g)[b]	(h)[c]
		GYMPY data				DAPC-120 data		
Year/Qtr	Total reenlistments	Same MOS reenlistments	New MOS reenlistments	Migration rate	Separations	Reenlistments	Unadjusted rate	MOS reup rate
7601					1,046	317	.3031	.2068
7602					1,432	573	.4001	.2731
7603					2,427	655	.2699	.1842
7604					2,120	732	.3453	.2357
7701					1,959	851	.4344	.2965
7702		Unavailable			2,705	1,049	.3878	.2647
7703					2,645	1,057	.3996	.2727
7704					1,925	937	.4868	.3322
7801					2,315	1,154	.4985	.3402
7802					2,439	960	.3936	.2686
7803					2,254	957	.4246	.2898
7804					2,347	1,236	.5266	.3594
7901	878	517	361		2,828	1,537	.5435	.3709
7902	617	379	238		3,372	1,356	.4021	.2745
7903	666	465	201		3,294	1,251	.3798	.2592
7904	1,023	699	324		2,129	1,194	.5608	.3828
8001	1,001	661	340		2,051	1,217	.5934	.4050
8002	775	514	261		1,757	858	.4883	.3333
8003	600	405	195		1,534	727	.4739	.3241
8004	699	471	228		1,262	789	.6252	.4267
8101	789	564	225		1,507	1,005	.6669	.4552
8102	829	701	128		1,556	962	.6183	.4220
Total	7,877	5,376	2,501	.3175				

[a](d) = (c) ÷ (a).

[b](g) = (f) ÷ (e).

[c](h) = [(f) x (1 - (d)] ÷ (e).

c. Exogenous Variables. Data on three exogenous variables were collected. The time span of the data corresponded to that of the reenlistment data. The variables considered were the unemployment rate, the Consumer Price Index (CPI), and the military pay to civilian pay (MP/CP) ratio.

(1) Unemployment Rate. The unemployment rate statistics were obtained from the Bureau of Labor Statistics (BLS) reports. Based on the job descriptions and Dictionary of Occupational Titles (DOT) codes found in AR 611-201, individual MOSs were matched as closely as possible to the general job classifications listed in the BLS unemployment statistics. Approximately 30 MOSs had no equivalent civilian job classification. In these cases, the unemployment statistic for unskilled laborers was employed. All unemployment statistics were unadjusted for seasonality and depicted in a quarterly fashion.

(2) Consumer Price Index. The CPI was obtained from the BLS monthly news release, "The Consumer Price Index." It was unadjusted for seasonality and reflected the average monthly index for US cities.

(3) Military Pay to Civilian Pay (MP/CP) Ratio. Data for the civilian pay component of the ratio were obtained from the appropriate yearly BLS publication, "National Survey of Professional, Administration, Technical and Clerical Pay" (NSPATC). The military component of the pay ratio was gathered from the Regular Military Compensation (RMC) figures as they are presented to the US Congress by DOD. The RMC is defined as the sum of basic pay, quarters and subsistence allowances, and the tax advantage that accrues because the allowances are not subject to Federal income tax. The computation of Federal income tax and tax advantage is based upon the assumption that the member takes the standard deduction. Unfortunately, for the purposes of pay comparison, equivalency between MOS and civilian job classifications could be found in only 30 cases. As a result, statistical analysis of the MP/CP ratio is, at best, severely limited in its usefulness.

d. Data Integration. Endogenous and exogenous variables were integrated as illustrated in Figure 4-5 to form the base case data set to be analyzed. Details of the automated processing necessary to integrate these data are presented in paragraph D-2 of Appendix D. Figure 4-5 illustrates the data elements of the data set using MOS 11B experience during the first and second quarters of FY 76. The data set provides data for each of the six inputs, i.e., reenlistment rates, SRB multipliers, migration rates, unemployment rates, military to civilian pay ratio, and the Consumer Price Index. The pay ratio element lacks data in the example since 11B was one of those skills for which earnings data were not available, as discussed in paragraph 4-3c(3). The integrated data set also provides skill (MOS and CMF) and zone identification. A scatter plot of Zone A integrated data for Infantrymen (11B) is shown in Figure 4-6. This plot provides historical trends of reenlistment rates at various SRB multipliers, CPI data, and unemployment data. Data for the MP/CP ratio was unavailable. As indicated in the graph, reenlistment rates for individual MOSs generally increased during this period, even when the SRB multiplier decreased. This phenomenon occurred in most of the military skills and was a major consideration in the type model selected to analyze the data. Paragraph 4-4a(4) discusses the statistical model in more detail. Figures 4-7 and 4-8 depict the integrated data for MOS 11B in Zones B and C, respectively. The trends between zones for MOS 11B are fairly representative of the entire data base in that reenlistment rates were generally higher and more stable for increasing years of service.

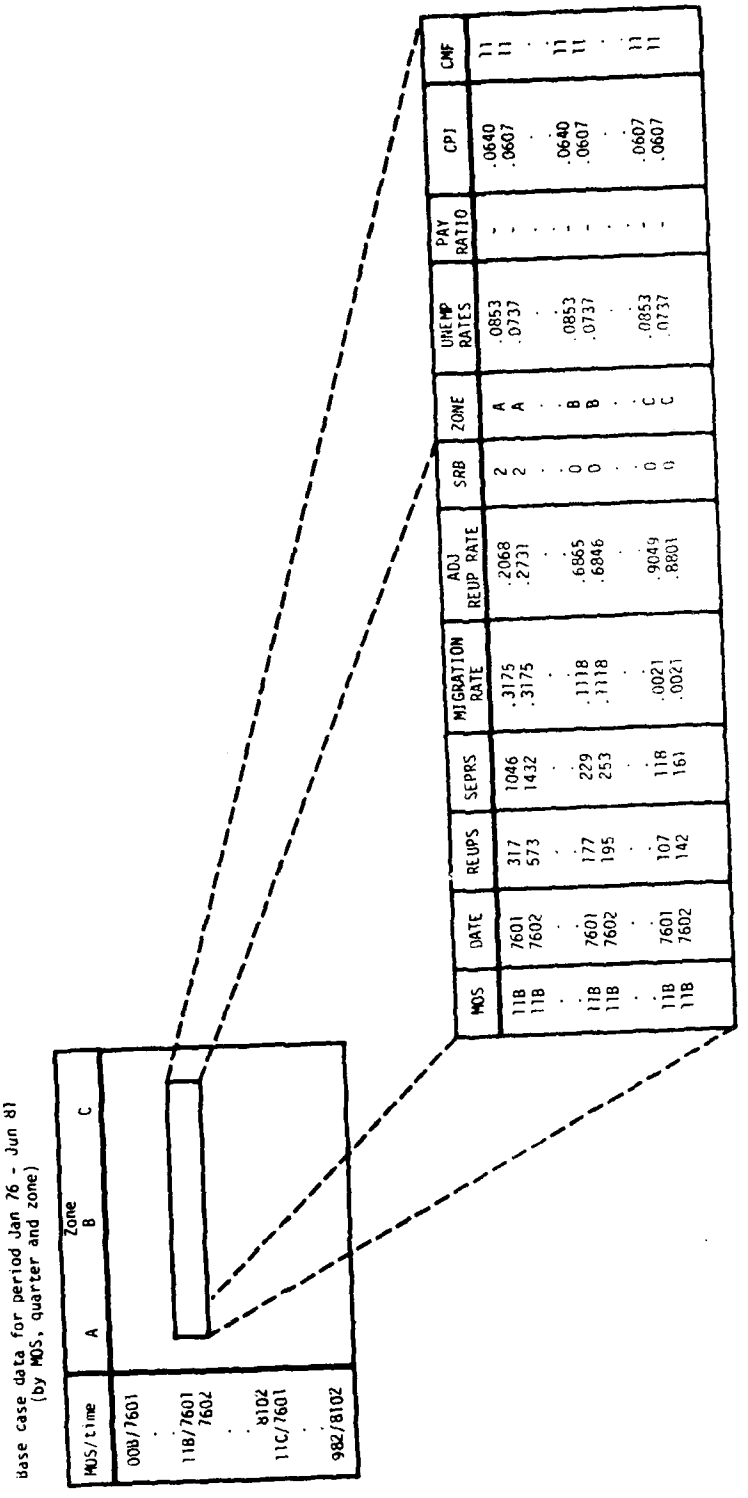

Figure 4-5. Example of Integrated Data for MOS 11B

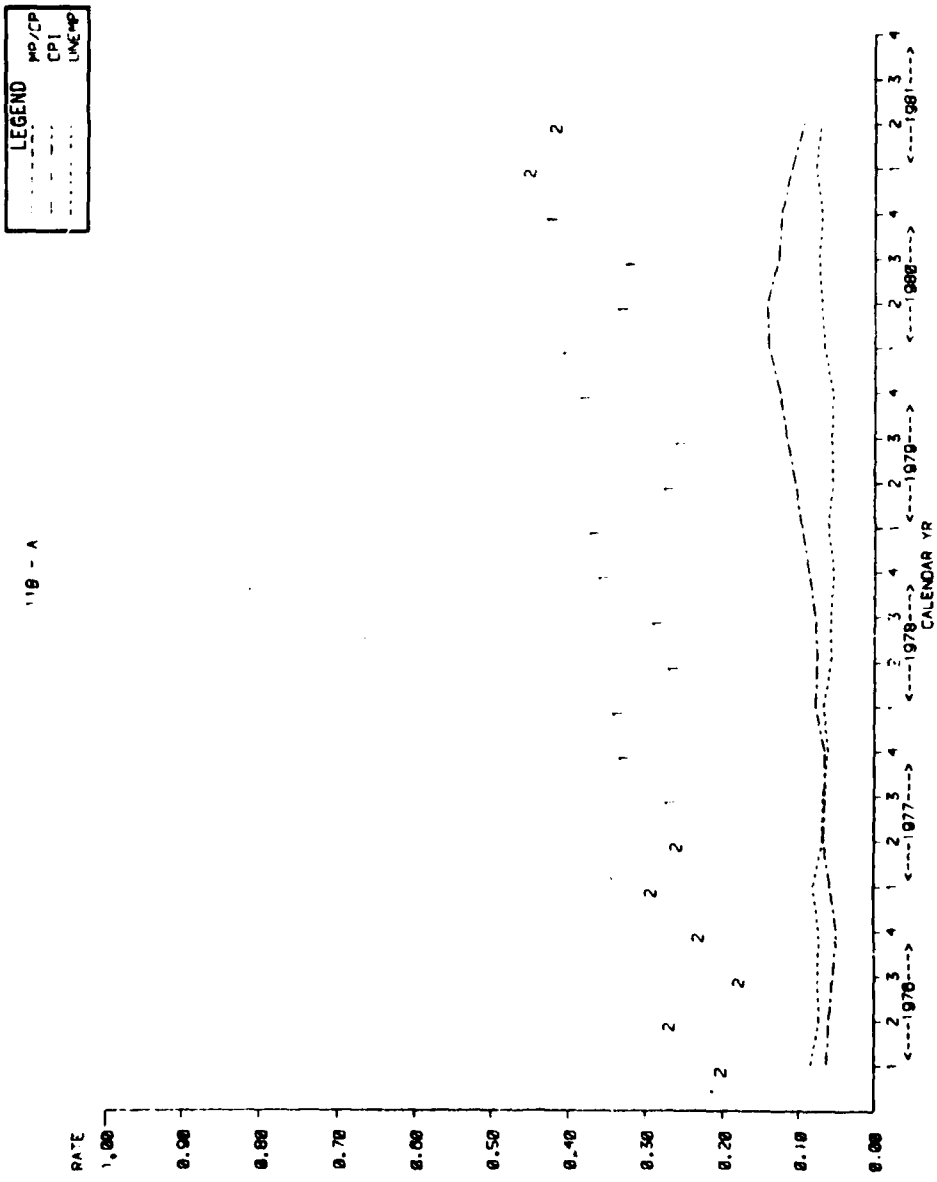

Figure 4-6. Reenlistment Rate vs SRB Multipliers and Exogenous Variables for MOS 11B in Zone A

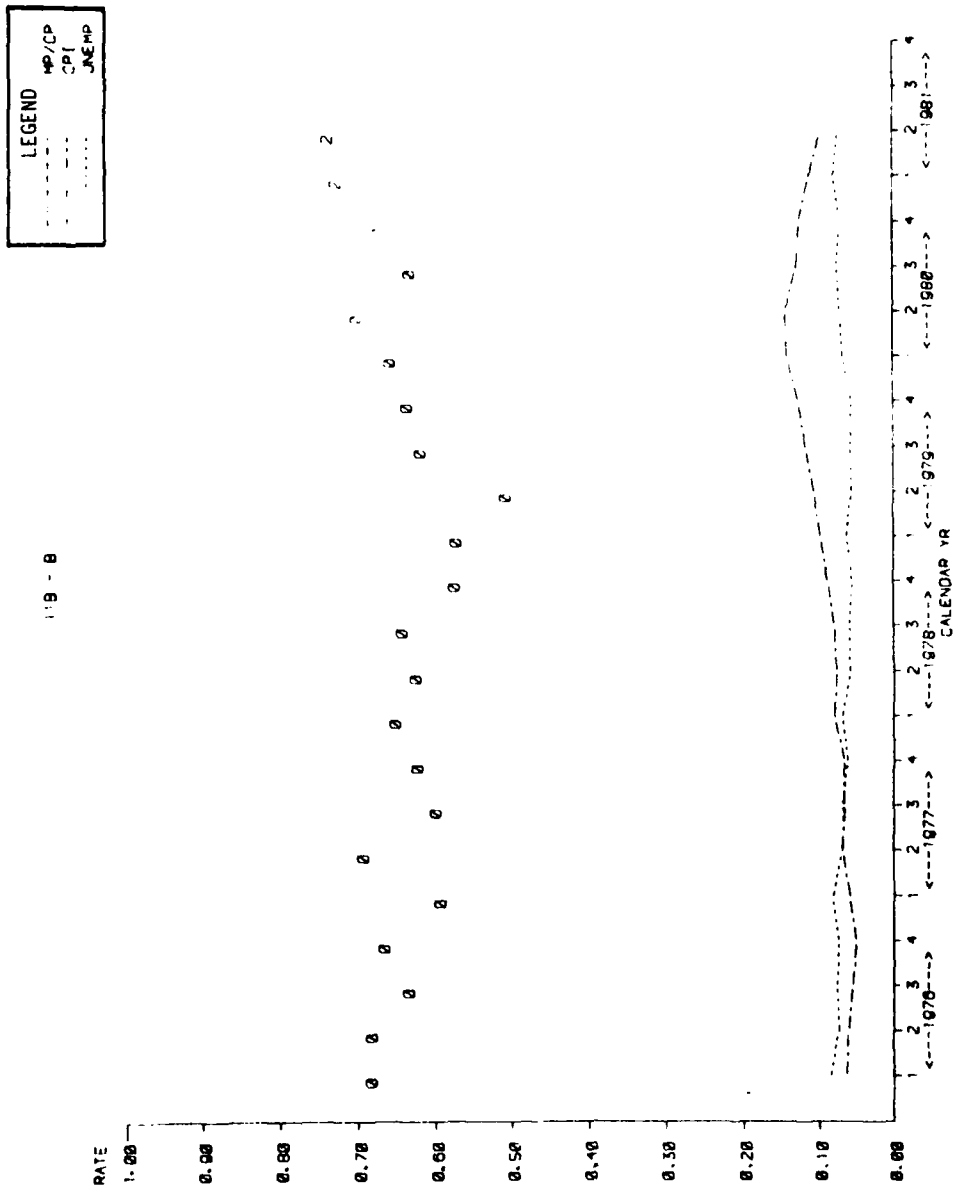

Figure 4-7. Reenlistment Rates vs SRB Multipliers and Exogenous Variables for MOS 11B in Zone A

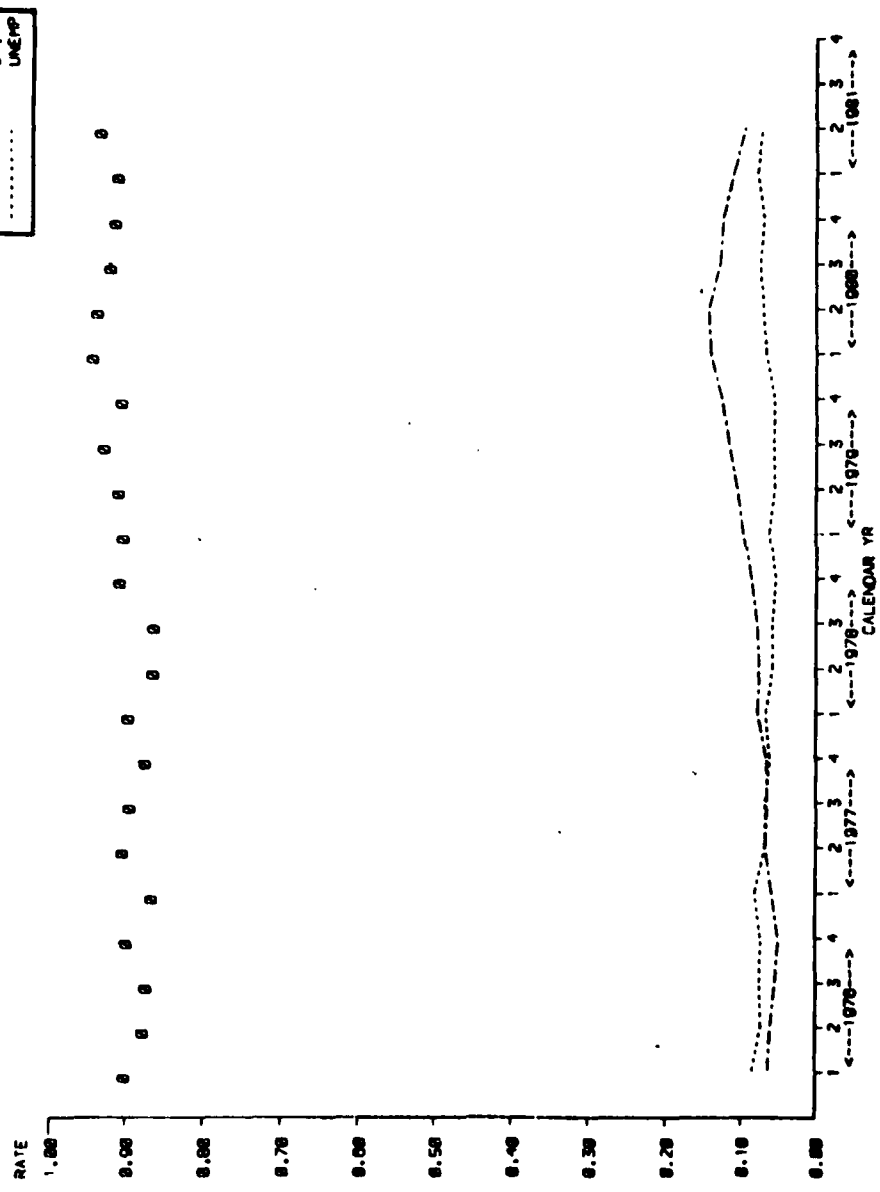

Figure 4-8. Reenlistment Rates vs SRB Multipliers and Exogenous Variables for MOS 11B in Zone B

4-4. STATISTICAL METHODOLOGY. This paragraph discusses the statistical methodology used to estimate the effect that SRB multipliers had on reenlistment rates. It addresses the formulation of a statistical model and the determination of a reliable sample size, as well as the interpretation of model output.

a. Model Formulation. The intent of the effectiveness analysis was to quantify the effects of the endogenous and exogenous variables on reelistment rates. Thus, the reenlistment rate was considered the dependent variable and the remaining factors (SRB multipliers and the exogenous variables) were independent variables.

(1) Importance of Time. Plots of these variables over time revealed a strong relationship between time and reenlistment rates. Generally, reenlistment rates increased from year to year even when the SRB multiplier decreased. Within this overall increasing trend, reenlistment rates exhibited strong cyclical characteristics by quarter. Reenlistments were usually "down" during the spring and summer and "up" in the fall and winter quarters. Based on the plot analysis, year and quarter were included as two additional independent variables.

(2) Problems with Low Density MOSs. Initial examination of the data for selected MOSs revealed substantial variability in the reenlistment rates of certain MOSs. This variability was identified with the number of quarterly separation eligibles of the MOS. Reenlistment rates represent the ratio of personnel who reenlist to the total personnel eligible to reenlist. Consequently, when the eligible pool is small, a small change in reenlistments will result in a large change in the reenlistment rate. See Figure 4-6, Infantryman (11B), versus Figure 4-9, the PERSHING Electronic Materiel Specialist (21G). These MOSs had approximately 1,000 and 10 separations per quarter, respectively. Analysis was conducted to determine the appropriate sample size of eligibles to assure a reliable base of reenlistment rates. Details of this analysis are in Appendix E (paragraph E-2b). The analysis revealed that 100 separations was the minimum sample size for Zone A. Due to the decreased fluctuation in reenlistment rates in Zones B and C, the minimum sample sizes for these zones were set at 50 and 25 separations per quarter, respectively.

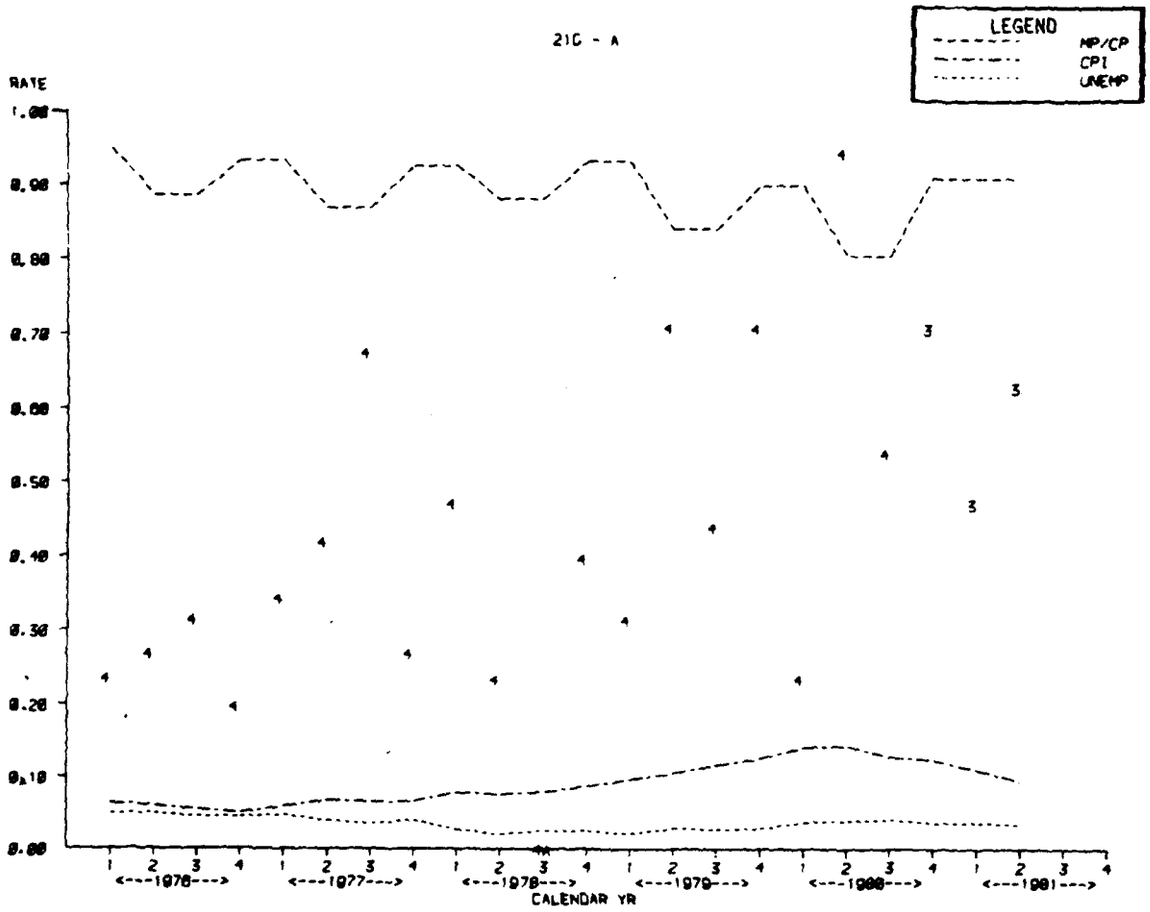

Figure 4-9. Reenlistment Rate Fluctuations for a Low Density Skill, MOS 21G

(3) Correlation Analysis. In order to gain an understanding of the relationships among the variables, correlation matrices (see Appendix E, Table E-2) were developed for those MOSs meeting the desired density requirement. Salient findings were:

(a) The correlation coefficient between CPI and time (year) was $r = 0.86$ for all MOSs with 22 quarters of data.

(b) Reenlistment rate was nearly as highly correlated with time as was the CPI. In 60 percent of the MOSs analyzed, the correlation coefficients range between 0.60 and 0.84.

(c) Correlations between reenlistment rate and SRB multipliers were inconclusive when examined on an MOS-by-MOS basis. The coefficients ranged from -0.67 to 0.74.

(4) Stepwise Regression. Results of the correlation analysis, in particular the wide variations obtained in correlation coefficients (between reenlistment rate and bonus level), suggested the need to quantify sources of variability by a stepwise procedure. Stepwise regression permitted the SRB multiplier to be "forced" into a given equation and retained, without sacrificing the flexibility of excluding any exogenous variable that contributed little to explaining the total variability in reenlistment rate. The specific model used was:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_3^2 + b_5X_3^3 + a_1Z_1 + a_2Z_2 + a_3Z_3$$

where:

Y = reenlistment rate

X_1 = SRB multiplier

X_2 = Year

X_3 = Quarter

Z_1 = Unemployment rate

Z_2 = Military pay/civilian pay ratio

Z_3 = Consumer Price Index

and b_0, b_1, b_2, b_3, b_4, a_1, a_2, a_3 are regression coefficients to be estimated.

Other statistical models considered and found less appropriate than this model were simple regression, logistic model, and time series analysis. Time series analysis was inappropriate since 5 1/2 years of quarterly observations did not equate to the 50 or 60 data points that are normally considered necessary. Appendix E (paragraph E-2a) documents the advantages and disadvantages of the other models that were considered.

b. Intrepretation of Regression Outputs. The solution to the multiple regression equation provides regression coefficients for each variable that contributed to explaining the variation in reenlistment rates. Each coefficient is a net coefficient in that it provides a measure of the effect of that variable after netting out the effect of all other variables.

(1) SRB Regression Coefficient. The b_1 term in the regression equation of paragraph 4-4a(4) is the net regression coefficient for the SRB multiplier variable (x_1) and is called the SRB coefficient. The computed value of this coefficient represents the net change in the reenlistment rate given a change in multiplier after considering the effects of time and the exogenous variables.

(2) Hypothesis Testing. Tests were conducted to determine if the computed SRB coefficients were chance occurrences when, in fact, SRBs do not induce reenlistments. The premise that SRBs do not induce reenlistments is the null hypothesis in this case, and the objective is to be able to reject this hypothesis with some degree of confidence. The Student t-test is the basis for this assessment with a 90 percent confidence level. The 90 percent confidence level sets the risk of concluding that the SRB has an effect when it does not at 1 time out of 10. SRB coefficients which passed the t-test were considered statistically significant, and the possibility of SRB coefficients of the observed size occurring by chance was rejected.

4-5. APPLICATION OF STATISTICAL MODEL. This paragraph addresses the results of applying the methodology discussed in paragraph 4-4. Multiple regression was used to determine the effect that SRB payments have on reenlistments at three levels. Military occupational specialty, career management field, and occupational skill group were the three levels considered. The study focused initially at the MOS level because this is the level at which SRB payments are made. However, the analytic results at the MOS level did not provide sufficient coverage of Army MOSs to be useful in the allocation of SRB funds by MOS. Focus then shifted to aggregates of skills such as the CMF level (the focal point for MOS management) and occupational skill groups (collections of similar MOSs without consideration of how the MOSs are managed within the Army).

a. MOS Level. There were approximately 330 MOSs in the data base. However, when the criteria for sample size (discussed in paragraph 4-4a(2)) were invoked, only 26 MOSs in Zone A had populations that were large enough for reliable statistical analysis. Regression was applied to the 26 MOSs with the result that only 6 out of the 26 had SRB coefficients sufficiently large that we could say they were significantly different from zero. Paragraph 4-4b(2) discussed the hypothesis testing to determine if the SRB regression coefficients were significant at a 90 percent confidence level.

b. CMF Level. CMF history was compiled by aggregating data for MOSs within the CMF. The aggregation was done by time period, SRB, and zone. For example, a Zone A record for CMF 91 that shows a Level 2 multiplier in first quarter 1976 would be the composite of all Zone A MOSs that belong to CMF 91 and had a Level 2 SRB in the same quarter. The Army has 30 CMFs, 26 of which were authorized a Zone A bonus during the period studied, as was shown in Figure 4-2. Applying the sample size criteria to the 8 candidates resulted in only 11 CMFs surviving for statistical analysis. The 11 CMFs were analyzed with the regression model, and 7 were found to have statistically significant SRB coefficients. The 7 CMFs for which measurement of the SRB effect was possible represent 66 MOSs which is only 20 percent of the Army's MOS inventory. While this was an improvement over the results from the individual MOS analysis, it left much to be desired.

c. Occupational Skill Groups. When developing the occupational skill groups, the emphasis was to place MOSs into logical groups of homogenous skills without attention to the way the Army manages these skills. This placement produced the 10 skill groupings that are shown in Table 4-3 along with the MOSs that were placed in each group. The result was skill groups which often crossed Army management (CMF) lines. Historical data for each skill group were compiled by aggregating data for the MOSs in the group by zone, time period, and SRB multiplier. This resulted in many of the skill groups having more than one multiplier in a quarter, particularly in Zone A. Figures 4-15 through 4-17 illustrate this observation using the history for the intelligence group. When multiple observations occurred in the same quarter, the larger SRB multiplier was usually associated with the larger reenlistment rate.

(1) All skill groups met the minimum sample size criteria in all zones. Regression was applied to skill groups that had sufficient variation in SRB multipliers and the results are summarized in Table 4-4. As shown in Table 4-4, the regression analysis provided estimates of SRB effect for all 10 groups in Zone A, 6 groups in Zone B and only 1 group in Zone C. The presence of the superscript "a" identifies those groups having a significant SRB regression coefficient.

Table 4-3. Occupational Skill Groups with MOS Identification

Skill groups	Number of MOSs	Density	Percent of Army
Direct combat[a]	10	138,679	22
Combat operations[b]	28	79,320	13
Communications/electronics operations[c]	16	59,811	9
Communications/electronic maintenance[d]	72	30,368	5
Mechanical maintenance[e]	48	68,876	11
Supply/service & transportation[f]	36	100,203	16
Medical[g]	27	40,279	6
Administration[h]	51	72,934	12
Engineer & construction[i]	24	19,725	3
Intelligence[j]	18	19,662	3

[a]MOS 11B, C, H, M; 13B, M; 19D, E, K, Z.

[b]MOS 12B, Z; 13C, E, F, R, W, Y, Z; 15D, E, J; 16B, C, D, E, H, J, P, R, S, T, Z; 17B, C; 82C; 93F; 95B.

[c]MOS 05B, 05C; 26Q, 26R; 31M, N, V, Z; 32D; 36C, D, E, K; 72E, G, H.

[d]MOS 21L; 22L; 23N, U, W; 24C, E, G, H, J, K, P, Q, R, T, U, V; 25J, L; 26B, C, D, E, H, K, L, T, V, Y; 27B, E, F, G, H, N, Z; 31E, J, S, T; 32F, G, H, Z; 33S; 34B, C, F, H, K, Y, Z; 35B, E, F, G, H, K, L, M, P, R, U; 36H, L; 41B, C, E; 45G; 46N; 68F, J.

[e]MOS 22N; 24L, M, N; 41J; 43M; 44B, E; 45B, D, E, K, L, N, T, Z; 52C, D; 61F; 62B; 63B, D, E, G, H, J, N, S, T, W, Y, Z; 67G, H, N, T, U, V, W, X, Y, Z; 68B, D, G, H, K, M.

[f]MOS 12E; 21G; 43E; 51M; 54C, E, Z; 55B, D, G, X, Z; 57E, F, H; 61B, C, Z; 64C, Z; 71N, P; 76C, J, P, V, W, X, Y, Z; 93E, H, J; 94B, F; 95C.

[g]MOS 01H; 42C, D, E; 91B, C, D, E, F, G, H, J, L, N, P, Q, R, S, T, V, W, Y; 92B, C, D, E.

[h]MOS 00E, J, U, Z; 02B, C, D, E, F, G, H, J, K, L, M, N, P, Q, R, S, T, Z; 03C; 71C, D, E, G, L, M, Q, R; 73C, D, Z; 74D, F, Z; 75B, C, D, E, Z; 79D; 81E; 83E, F; 84B, C, F, T, Z.

[i]MOS 00B; 12C, 12F; 51B, C, G, H, K, N, R, T, Z; 52E; 62E, F, G, H, J, N; 81B, C, Z; 82B, D

[j]MOS 05D, G, H, K; 17K, M; 95D; 96B, C, D, H, Z; 97B, C; 98C, G, J, Z.

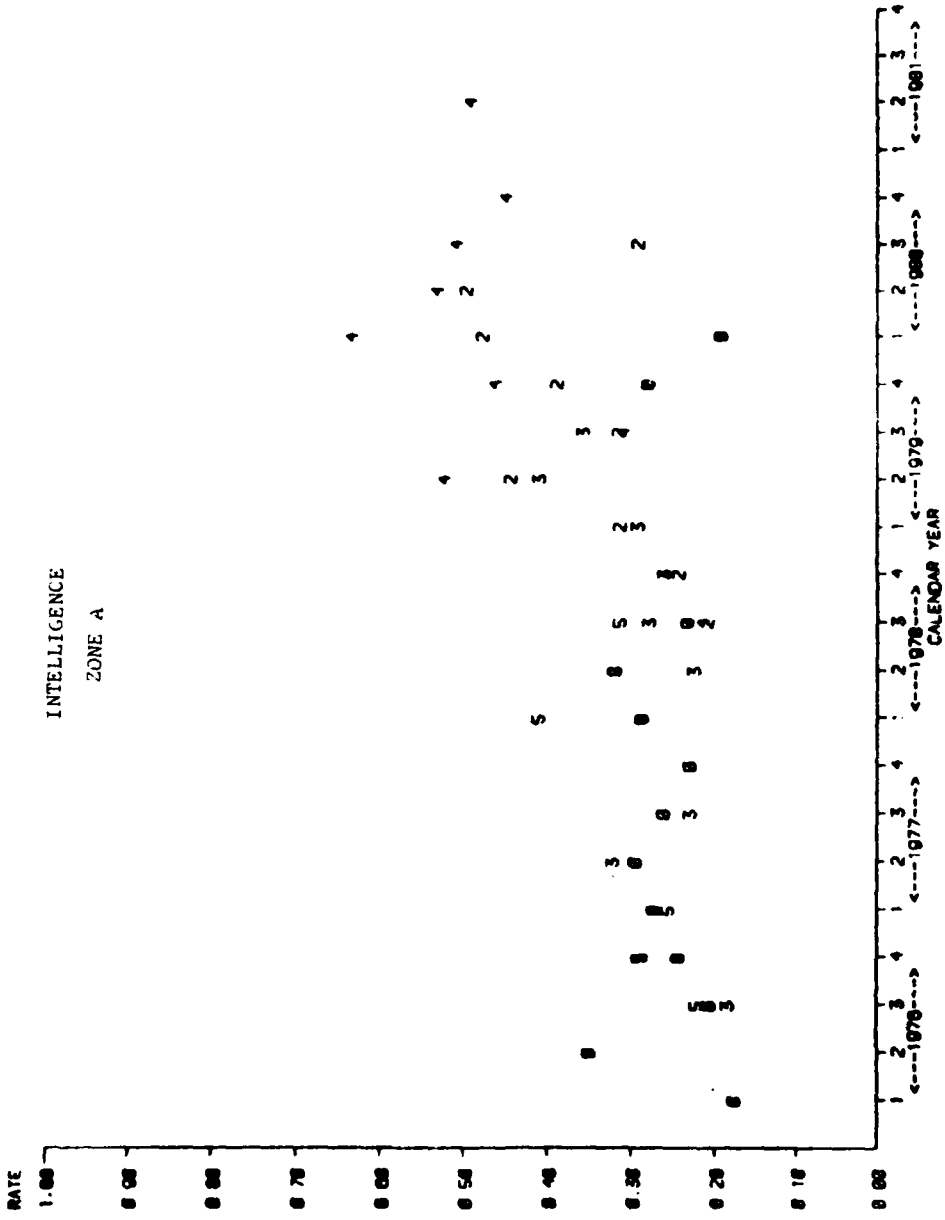

Figure 4-10. Reenlistment Rates vs SRB Multipliers for the Intelligence Group in Zone A

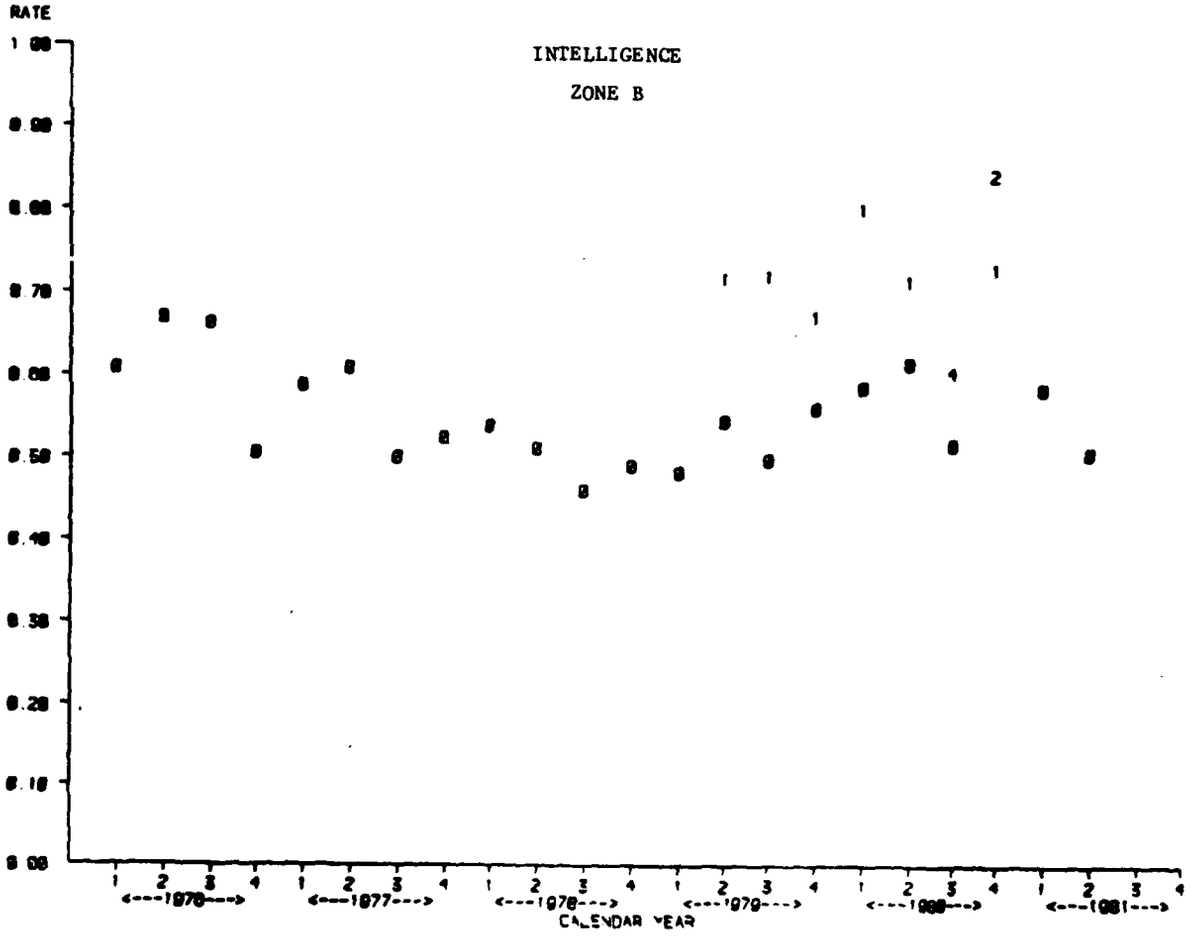

Figure 4-11. Reenlistment Rates vs SRB Multipliers for the Intelligence Group in Zone B

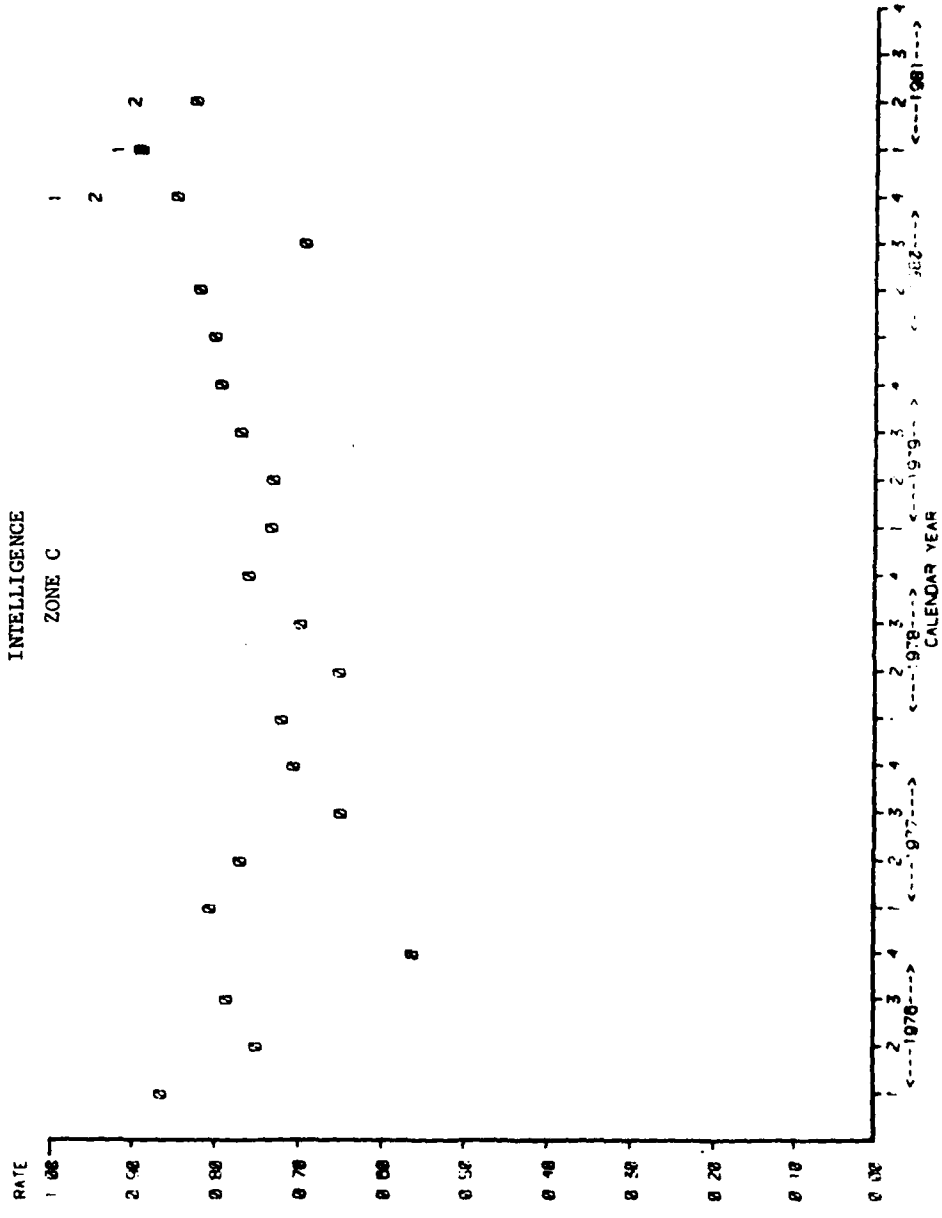

Figure 4-12. Reenlistment Rates vs SRB Multipliers for the Intelligence Group in Zone C

Table 4-4. Regression Results for Occupational Skill Groups

Zone	Skill group	(a) b_0	(b) SRB level b_1	(c) Year b_2	(d) Qtr b_3	(e) Qtr^2 b_4	(f) Qtr^3 b_5	(g) Unemp a_1	(h) Pay ratio a_2	(i) CPI a_3	(j) equation R^2	(k) SRB level r^2
A	Direct combat[a]	.146	.048	.042	.031	-.043	.009				.8124	.1747
	Combat operations[a]	-.070	.030	.054	.426	-.214	.031				.6445	.0618
	Communications/electronic maintenance[a]	.330	.026	.034	-.067		.002				.6128	.0965
	Communications/electronic operations[a]	.278	.032	.055	-.066		.003				.7239	.0668
	Intelligence[a]	.283	.026	-.005	-.027			-2.413	-.066	1.845	.6115	.0502
	Engineer/construction[a]	.298	.052	.040	-.089		.003				.5795	.1133
	Supply/service/transportation[a]	.180	.062	.061	-.049		.002	1.153			.7019	.2117
	Mechanical maintenance[a]	.386	.024	.045	-.106		.004				.6163	.0389
	Administration	.447	-.022	.051	-.099		.004				.8071	.0164
	Medical[a]	-.047	.036	.024	.294	-.155	.023			1.381	.4770	.1525
	Total Army (all multipliers)	.086	.009	.047	.278	-.152	.023	-.993		.511	.7302	.0177
	Total Army (multipliers 0-3)	.098	.026	.052	.279	-.154	.024	-.917			.7670	.0922
B	Direct combat[a]	.378	.054	.008	.023		-.001	2.826			.6692	.5849
	Combat operations[a]	.495	.079		-.140	.090	-.014	2.935			.4117	.0919
	Electronic maintenance[a]	-1.31	.076	1.040	.143		-.007	3.583	1.376	2.803	.7641	.2733
	Intelligence	.639	.024	-.040	-.045		.002		-.127	2.205	.5582	.2698
	Supply/service/transportation[a]	-2.99	.070	-.023	.394	-.074		3.203	2.065	3.181	.6882	.4523
	Mechanical maintenance[a]	.563	.080	.004	.012	-.003		1.091			.8904	.8443
	Medical[a]	.527	.119	-.022	-.044		.002			1.692	.5259	.4188
	Total Army (all multipliers)	.207	.035	-.006	.102	-.036	.004	3.948	.122	.728	.7778	.0468
	Total Army (multipliers 0-3)	.285	.032	-.005	.021		-.003	3.665	.101	.702	.4466	.1327
C	Intelligence	.534	.029	-.011	-.085		.003	7.812	-1.63	2.153	.6928	.3948
	Total Army	.737	.055	.004	.003			.113	.093	.314	.8149	.0758

[a]The b_1 (SRB level regression coefficient) is significantly different from 0 at the 0.10 level of significance.

NOTE:

Column (j) = Multiple R^2 for equation

Column (k) = The amount of variance accounted for by the SRB level

(2) The failure to reliably measure the SRB effect on reenlistment because of insignificant SRB coefficients can not be interpreted to mean that the SRB does not affect reenlistments. There is the strong "a priori" assumption that the SRB is an inducement to reenlistments, and this analysis supports that assumption at the occupational group level in the majority of cases. Where it does not, the problem is generally a lack of data upon which to measure the effect. For example, the administration group shows a negative SRB regression coefficient. Does this mean that administrative personnel react negatively to the bonus? Examination of the historical data revealed that MOSs within the administration group were seldom offered a bonus during the period studied and therefore they had little opportunity to react to a bonus. Zone C results are not as firm as are the results for Zones A and B. This is not surprising since personnel in Zone C were not authorized a bonus prior to 1980; therefore, only 1 1/2 years of experience for this group were available.

d. The Effect of Exogenous Variables. The CPI was positively correlated with the reenlistment rates observed from January 1976 to June 1981. The CPI often entered the stepwise regression equations explicitly; when it did not enter explicitly, it usually did so implicitly because of the high correlation between the CPI and the time variable. Neither the unemployment rate nor the military pay/civilian pay ratio were consistently correlated with reenlistment rates. Unemployment rates generally decreased or stablized during 1978 and 1979, whereas reenlistment rates increased throughout the period. The MP/CP ratio was seldom available for analysis, since pay data were obtained for only 30 civilian skills that could be matched to an equivalent military skill (MOS).

4-6. SRB EFFECTIVENESS MEASURES AND THEIR USE IN ALLOCATING SRB PAYMENTS TO MOS. This section discusses the SRB effectiveness measures that are used in the allocation of bonuses to Army MOSs.

a. SRB Effectiveness Measures

(1) As discussed in paragraph 4-5c(1), regression analysis provided SRB effectiveness measures (SRB coefficients) for skill groupings where sufficient data were available. The regression based coefficients were itemized in column b of Table 4-4. Where there were no regression coefficients for a skill, it was assumed that the skill's reaction to the bonus would be analogous to the average reaction of skills with regression based SRB coefficients. Therefore, analogy to the regression-based coefficients was used to compile the complete set of effectiveness measures for all 10 groups in the three zones that are shown in Table 4-5.

Table 4-5. SRB Effectiveness Coefficients by Occupational Group and Zone

Skill group	Zone A	Zone B	Zone C
Direct combat	.048	.054	.059
Combat operations	.030	.079	.084
Communications/electronic maintenance	.026	.076	.081
Communications/electronic operations	.032	.066	.071
Intelligence	.026	.024	.029
Engineer and construction	.052	.086	.091
Supply/service and transportation	.062	.070	.075
Mechanical maintenance	.024	.080	.085
Administration	.029	.063	.068
Medical	.036	.119	.124

(2) Three Zone B coefficients were extrapolated using the average increase from Zone A to Zone B for applicable groups with Zone B coefficients. In Zone C, only the intelligence group had statistical data available. This group showed a 0.05 increase in the Zone C coefficient (0.029) from the Zone B coefficient (0.024). While the Zone C coefficient was not statistically significant, it was judged to have practical merit and the 0.05 increase was applied to Zone B coefficients to derive Zone C coefficients for the remaining nine groups. Practical reasons for using the Zone C experience include:

(a) Lack of sound basis to assume Zone C personnel will not respond to a bonus if given the opportunity. However, it is reasonable to assume that the bonus impact might be small since Zone C reenlistment rates approach 80 percent to 95 percent without a bonus.

(b) The 0.05 increase caused Zone C reenlistment rates to approach 100 percent at a level 2 or 3 SRB multiplier even though a Level 5 is the maximum allowed. Therefore, an increase larger than 0.05 would tend to lower the SRB multiplier available to Zone C even further.

b. Use of the Effectiveness Coefficients in Allocating Bonuses. The primary purpose of developing the SRB effectiveness measures was to use them in estimating what reenlistment rates to expect if a given SRB multiplier was assigned. One obvious way to do this would be to solve the regression curve for the desired SRB multiplier. However, there are two inherent weaknesses in this approach.

(1) The level of resolution at which bonuses are assigned (MOSs) differs from the level at which the effectiveness measures were developed (occupational groups).

(2) If the level of resolution were compatible, projecting reenlistment rates with the regression curve would require estimates for each exogenous variable, and projecting future economic conditions would significantly increase the difficulty of using the methodology.

For these reasons, the SRB effectiveness measures are used in conjunction with the current reenlistment rate and bonus multiplier for a skill to estimate the expected reenlistment rates for that skill across the range of possible multipliers. This methodology assumes that the current reenlistment rate would include the effect of the CPI, unemployment, etc. Several MOSs were analyzed to determine how estimates based on the current reenlistment rate approach would vary from estimates produced by the MOS regression equations. The results from the two approaches indicated a difference of 27 reenlistments for MOS 11B, but were usually within one reenlistment of each other for most of the MOSs analyzed. Table 4-6 illustrates the current reenlistment rate approach. As shown in the matrix labeled "expected reenlistment rate by multiplier," the current reenlistment rate is associated with the current SRB multiplier in the appropriate cell. The expected reenlistment rate at each of the other levels is computed by adding or subtracting the value of the SRB coefficient as appropriate. For example, in Zone A, the expected reenlistment rate without a bonus equals the current rate adjusted for migration (0.36) minus the SRB coefficient (0.048) or 0.312. It is expected that as personnel attain the maximum SRB payment allowed ($16,000) that there will be no further improvement in the reenlistment rate resulting from SRB. This occurs in Zone A at multiplier 5 and in Zones B and C at multiplier 4. Reenlistment improvement terminates at multiplier 2 in Zone C because it is impossible to reenlist more than 100 percent of the eligibles.

Table 4-6. The Use of SRB Coefficients to Project Expected Reenlistment Rate Improvement by Multiplier for MOS 11B

Zone	SRB coefficient	Current multiplier	Current reup rate[a]	Expected reenlistment rate by multiplier						
				0	1	2	3	4	5	6
A	.048	1	.36	.312	.360	.408	.456	.504	.552	.552
B	.054	0	.64	.640	.694	.748	.802	.856	.856	.856
C	.059	0	.93	.930	.989	1.000	1.000	1.000	1.000	1.000

[a]Adjusted for migration.

4-7. SUMMARY AND OBSERVATIONS. Major observations from the SRB effectiveness analysis are summarized below:

a. Different skills appear to have responded differently to SRB multipliers during 1976 to mid-1981. This was documented to some extent at the MOS and CMF level where sufficient data were available. The most reliable evidence, however, was obtained when MOSs were grouped into collections of similar skills without regard to the way the skills are managed within the Army.

b. Reenlistment rates increased significantly during the period covered. It is likely that reenlistment rates are moving together with additional variables that the study was unable to quantify, such as the improved perception of military service in recent years. Since time and reenlistment rates were so strongly related, the effectiveness measures developed herein should be reexamined after 2 years or even sooner if reenlistment trends change significantly.

c. The SRB coefficients developed in the regression analysis are relative measures of the effect of the SRB. As such, they are not directly comparable to the improvement factors of previous studies. When the SRB coefficients are used to derive improvement factors for selected MOS, these factors are sometimes lower and sometimes higher than those currently used to manage the SRB Program. This is to be expected since the factors that are currently used represent the average experience for all MOSs.

d. Expected reenlistment rate improvements for an MOS are computed by adjusting the skill's current reenlistment rate for historical SRB effect. This method produces static rates that represent the time period of the current rate. However, as the base time period (for current reenlistment rate) approaches the projected time period, the limitation of static estimates should decrease.

e. The CPI was positively correlated with the historical reenlistment rates of occupational skill groups and it appeared to have some influence on reenlistment decisions occurring from January 1976 to June 1981. However, since the most reliable regression equations represent skill groups and SRBs are assigned at the MOS level, the historical effect of CPI on reenlistment rates (as represented in the regression equations) could not be applied directly in the allocation methodology. The allocation methodology incorporates the effect of CPI and other external variables implicitly through the use of current reenlistment rates as the base for estimating expected reenlistment rates. Neither the unemployment rate nor the MP/CP ratio was consistently correlated with the reenlistment rates. Unemployment rates generally decreased or stabilized during 1978 and 1979, whereas the reenlistment rates generally increased thoughout the period. The MP/CP ratio was seldom available for analysis since earnings were obtained for only 30 civilian skills that could be matched to an equivalent military skill.

f. Emphasis should be placed on identifying and maintaining machine-readable sources of data important to the management of the SRB Program. This study was hampered in that the SRB history was only available in hard copy form, and retention history older than 200 days had to be regenerated at considerable expense in terms of time and computer resources.

CHAPTER 5

SRB CRITICALITY SELECTION CRITERIA METHODOLOGY

5-1. GENERAL. Department of Defense (DOD) Instruction 1304.22 lists a number of criteria which must be taken into account when determining which military occupational speciality (MOS) will be awarded a selective reenlistment bonus (SRB). These criteria, while often based on clear-cut objective data, have no objective scale upon which they can be judged. The concept of criticality weight (CW) and its subsequent development is an attempt to assign a scale to these factors, perform a relative comparison and tabulate them into a form which can be used to compare the relative criticality weight of each zone of an MOS under consideration. The practical planning concerns of the US Army Military Personnel Center (MILPERCEN) program managers were reenlistment rates, career manning levels, training investment, and criticality to the defense mission. Taking into consideration the guidance provided by the DOD instruction and the practical planning concerns of MILPERCEN program managers, it was determined by the study team in coordination with those managers that the criteria which most appropriately represented the criticality of an MOS and zone to receive an SRB were:

- Percent of fill of the zone within the MOS.
- Percent of fill of the MOS.
- Reenlistment rate of the zone within the MOS.
- Reenlistment migration rate of the zone within the MOS.
- Percent of personnel fill desired in the zone within the MOS.
- Percent of personnel fill desired in the MOS.
- Density of the MOS.
- Replacement training costs for the zone within the MOS.
- Mission essentiality of the MOS.

5-2. DEVELOPMENT OF CRITICALITY WEIGHTS. The development of criticality weights encompasses several logical steps. These steps are the collection of raw data, the conversion of the data into scalar value weights, the development of importance factors for the various categories of data, the manipulation of the scalar value weights by the importance factors and the tabulation and normalization of the individual criticality weights for each MOS and zone.

5-3. COLLECTION OF DATA

a. Objective Data. Fiscal year 80 MILPERCEN records provided data for the first seven categories listed in paragraph 5-1. Data for the eighth category (replacement training costs for the zone) were obtained from the September 1980 Military Occupational Speciality Training Cost Handbook (MOSB). Based upon instructions in the MOSB, the total "weighted average variable" cost was used. The skill levels of 1, 2, and 3 were assumed to correspond to Zones A, B, and C, respectively.

b. Subjective Data. The ninth category of data (mission essentiality of the MOS) was not available from any existing reports. The definition of mission essentiality, as derived jointly by the study proponent and the study team, was "the relative importance of an MOS that makes it indispensable in the conduct of the combat mission of the Army." Managers and decisionmakers in MILPERCEN and the Office of the Deputy Chief of Staff for Personnel (ODCSPER) were asked to participate in an application of the Delphi technique and rate the mission essentiality of all existing career management fields (CMF). In determining the mission essentiality of the CMF, they were asked to rank it as a 1, 2, or 3 with 1 being the most essential and 3 being the least essential. Once this was completed the MOSs belonging to each CMF were then assigned the mission essentiality of its parent CMF. This resulted in 83 MOSs being ranked as the most essential, 136 MOSs falling in the middle ranking, and 111 declared least essential.

5-4. VALUE WEIGHT ASSIGNMENT. In order to be able to compare the raw data associated with each of the nine categories the data were converted to a scalar basis. These scalars have been given the name of criticality selection criteria value weights (CSCVW). In the development of the CSCVW, numerous combinations of weighting systems were tried. The relationship between the raw data categories and the associated CSCVW ranges was assumed to be linear. The upper and lower bounds were designed to encompass the largest possible number of points of FY 80 data. It was assumed that the range found in the FY 80 data would be representative of other fiscal years. The weights which ultimately were found to best satisfy the general conditions of the raw data are displayed in Table 5-1. It should be noted that the CSCVW range is constant for all categories (1 to 100).

5-5. SELECTION CRITERIA IMPORTANCE FACTORS. In order to properly assess the relative importance of the nine data categories, the selection criteria importance factors (SCIF) were developed. The SCIF were developed using the Delphi technique, polling the same persons in ODCSPER and MILPERCEN as previously mentioned in paragraph 5-3b. Those polled were asked to rate, independently, the nine categories of data. The rating for each category could be from 1 to 5, with 1 being least important and 5 being very important. The SCIF for each criterion was computed by totaling the number of points each criterion received and dividing by 5 times the number of respondents. The product of this survey is shown in Table 5-1. The SCIF can be updated or resurveyed by the user at anytime desired. However, it is probably safe to say that the SCIF as now depicted will suffice for at least several years.

Table 5-1. Criticality Selection Criteria for Each Zone of an MOS
(page 1 of 3 pages)

Criticality selection criteria	SCIF	Data range	Value weight
1. Percent personnel fill of the zone	.573	≥ 100%	1
		95 - 99	10
		90 - 94	20
		85 - 89	30
		80 - 84	40
		75 - 79	50
		70 - 74	60
		65 - 69	70
		60 - 64	80
		55 - 59	90
		< 55	100
2. Percent personnel fill of the MOS	.573	≥ 100%	1
		95 - 99	10
		90 - 94	20
		85 - 89	30
		80 - 84	40
		75 - 79	50
		70 - 74	60
		65 - 69	70
		60 - 64	80
		55 - 59	90
		< 55	100
3. Reenlistment rate of the zone	.718	≥ 95%	1
		90 - 94	5
		85 - 89	10
		80 - 84	15
		75 - 79	20
		70 - 74	25
		65 - 69	30
		60 - 64	35
		55 - 59	40
		50 - 54	45
		45 - 49	50
		40 - 44	55
		35 - 39	60
		30 - 34	65
		25 - 29	70
		20 - 24	75
		15 - 19	80
		10 - 14	85
		5 - 9	90
		1 - 4	95
		< 1	100

Table 5-1. Criticality Selection Criteria for Each Zone of an MOS
(page 2 of 3 pages)

Criticality selection criteria	SCIF	Data range	Value weight
4. Reenlistment migration rate of the zone	.709	< 1%	1
		1 - 4	10
		5 - 9	20
		10 - 14	30
		15 - 19	40
		20 - 24	50
		25 - 29	60
		30 - 34	70
		35 - 39	80
		40 - 44	90
		≥ 45	100
5. Percent personnel fill desired in the zone	.655	< 85%	1
		85 - 89	10
		90 - 94	20
		95 - 99	30
		100 - 104	40
		105 - 109	50
		110 - 114	60
		115 - 119	70
		120 - 124	80
		125 - 129	90
		≥ 130	100
6. Percent personnel fill desired in the MOS	.645	< 85%	1
		85 - 89	10
		90 - 94	20
		95 - 99	30
		100 - 104	40
		105 - 109	50
		110 - 114	60
		115 - 119	70
		120 - 124	80
		125 - 129	90
		≥ 130	100

Table 5-1. Criticality Selection Criteria for Each Zone of an MOS
(page 3 of 3 pages)

Criticality selection criteria	SCIF	Data range	Value weight
7. Density of the MOS	.500	≥ 5000	1
		4500 - 4999	10
		4000 - 4499	20
		3500 - 3999	30
		3000 - 3499	40
		2500 - 2999	50
		2000 - 2499	60
		1500 - 1999	70
		1000 - 1499	80
		500 - 999	90
		< 500	100
8. Replacement training cost for the zone	.609	< 5 $000	1
		5 - 10	10
		10 - 14	20
		15 - 19	30
		20 - 24	40
		25 - 29	50
		30 - 34	60
		35 - 39	70
		40 - 44	80
		45 - 49	90
		≥ 50	100
9. Mission essentiality of the MOS	.827	III	1
		II	50
		I	100

5-6. FORMULATION OF THE CRITICALITY WEIGHT. The actual formulation of the individual MOS/zone criticality weight can be expressed as:

$$\frac{\sum_{I=1}^{9} (SCIF_I)\ (CSCVW_I)}{9}$$

Put simply, the criticality weight is derived by multiplying the SCIF for each category by the CSCVW for the same category, adding the 9 products and normalizing by dividing by 9. An example of the criticality weight computation for MOS 11B, Zone A is provided in Table 5-2.

Table 5-2. Criticality Weight Computation (MOS 11B, Zone A)

Criteria category	Raw data	Value weight	X	Importance factor	=	Criticality weight
1	88	30		.573		17.19
2	100	1		.573		.57
3	54	45		.718		32.31
4	33	70		.709		49.63
5	100	40		.655		26.20
6	100	40		.645		25.80
7	63,147	1		.500		.50
8	5,835	10		.609		6.09
9	I	100		.827		82.70
						240.99
					CW =	26.78

The computation of the criticality weight continues beyond the point shown in Table 5-2. It is, however, at this point that the method of computation diverges. Chapter 6 depicts the computation of criticality weights as a function of MOS/zone group. Appendix G discusses an alternative method wherein the criticality weight is computed as a function of incremental utility of each reenlistment in the MOS/zone.

5-7. OBSERVATIONS. The validity of the data associated with the first seven criteria decreases as the time from date of collection increases. Therefore, it should be updated as often as is feasible and not less than annually. Data for replacement training costs for the zone should be renewed as the MOSB is updated. The data associated with mission essentiality of the MOS should retain validity for at least several years; however, reassessment and resurveying would not be out of order at an earlier date.

5-8. SUMMARY. The criticality weights should be updated and recomputed at least annually and perhaps as often as every time the SRB allocation model is run. A description of the criticality weight model is in Appendix D. It should be noted, however, that the automated routines may require minor changes as data sources and subsequent formats may be different. Appendix F is a brief summary of a limited sensitivity analysis conducted on the criticality weight computation process. It is impossible to state the degree of reliability associated with the elements of mission essentiality and the selection importance criteria factors. These elements were derived from DELPHI surveys which were not replicated. The method of value weight assignment was based upon the subjective judgment of the study team; therefore, its reliability is at this point, a nonquantifiable entity.

CHAPTER 6

SRB ALLOCATION METHODOLOGY

6-1. INTRODUCTION. This chapter explains the methodology proposed to allocate the selective reenlistment bonus (SRB) budget. Paragraph 6-2 is devoted to formulating the SRB allocation problem as an integer programing problem. Paragraph 6-3 reports on the Mixed Integer Program (MIP) operating mode of the Sperry UNIVAC 1100 Functional Mathematical Programming System (FMPS). This programing package can be used to solve the problem formulated in paragraph 6-2. Paragraph 6-4 identifies the data used to construct the files with numerical values for the parameters specified in paragraph 6-2. Paragraph 6-5 gives information on the preprocessor and postprocessor used to facilitate the users' access to the FMPS. Paragraph 6-6 describes the relationship between an optimal SRB allocation and a linear programing allocation, and paragraph 6-7 presents the results of a test application of the SRB study allocation procedure.

6-2. SRB ALLOCATION METHODOLOGY. The following methodology was formulated to determine an optimal allocation of SRB funds to competing Military Occupational Specialties (MOS) by zones of eligibility. It formulates the SRB allocation problem as an integer programing (IP) problem. Expressed in mathematical notation an integer programing formulation of the problem of deciding on appropriate SRB multipliers is:

$$\text{Maximize} \sum_{q} \sum_{i} C_{qi} X_{qi}$$

$$\text{such that} \sum_{i} X_{qi} = 1 \quad \text{, for each MOS/zone, } q$$

$$\sum_{q} \sum_{i} b_{qi} X_{qi} \leq B$$

where the parameters are:

C_{qi} - the criticality weight points of total reenlistees in MOS/zone q when bonus multiplier is i

b_{qi} - the total bonus payments made to reenlistees in MOS/zone q when bonus multiplier is i

B - Budget assigned to reenlistment bonus payments

The following variables are used:

X_{qi} - variables each of which is 1 for the level i at which bonus is paid in MOS/zone q and 0 otherwise

6-3. IMPLEMENTATION OF THE SRB ALLOCATION METHODOLOGY

a. Even a small SRB allocation problem yields a large number of cases that have to be examined in order to determine an optimal allocation. Only computers make the solution of the approach formulated in paragraph 6-2 possible.

b. In general, routines for solving integer programing problems have not been as successful for this type of problem as linear programing routines have been with linear programing problems. Nevertheless, because the SRB problem has a special structure, an integer programing routine was attempted to solve the problem. The Mixed Integer Program of the Functional Mathematical Programming System (MIP - FMPS) was used for this purpose. Documentation on this system is contained in Functional Mathematical Programming System: FMPS Level 9R1 Programing Reference (Sperry UNIVAC series 1100).

6-4. DATA REQUIREMENTS

a. The input parameters to MIP-FMPs are of three types as specified in paragraph 6-2.

(1) Criticality weight points (C_{qi}) of total reenlistees in MOS/zone q when bonus multiplier is i. The criticality weight concept, developed by the SRB Study, is a means of quantifying the contribution of reenlistments to the Army mission as measured by criticality weight points.

(2) Cost (b_{qi}) of the total bonus payments made to reenlistees in MOS/zone q when bonus multiplier is i.

(3) Budget (B) assigned to make reenlistment bonus payments. The size of the budget is a policy decision.

b. The inputs for cost and criticality weight points are derived in part from the effectiveness coefficients and the criticality weights (CW) developed in Chapters 4 and 5, respectively. The following additional data, available from the US Army Military Personnel Center (MILPERCEN), are also required for each MOS/zone:

(1) The number of persons eligible to reenlist.

(2) The number of reenlistments required.

(3) The monthly pay per individual to which the multiplier will be applied and the number of years of the reenlistment. A limitation of $16,000 on individual reenlistment bonus payments must also be taken into account.

c. The bonus payment at multiplier i for MOS/zone q will be i times the reenlistee's monthly payment times the number of years for which the reenlistment is made. No multiplier is assigned to an MOS/zone if the resulting value calculated above would be in excess of $16,000.

d. The anticipated reenlistments per MOS/zone are the smaller of:

(1) Number of reenlistments with no bonus + i (incremental reenlistments per unit of multiplier).

(2) Number of eligibles, as illustrated in Table 6-1.

e. Costs of bonus payments are: b_{qi} = (individual bonus payments at multiplier i for MOS/zone q) x (reenlistments at multiplier i for MOS/zone q) as illustrated in Table 6-2.

f. Criticality weight points (C_{qi}) are calculated only for MOS/zones for which a requirement for reenlistments exists. In such a case, C_{qi} is evaluated as the smaller of:

(1) $\frac{\text{Reenlistments at multiplier i for MOS/zone q}}{\text{Requirements for reenlistments MOS/zone q}}$ x CW of MOS/zone q

(2) CW of MOS/zone q

as illustrated in Table 6-3. In the above calculation criticality weights are modified by a fraction composed of the projected number of reenlistments divided by the number of required reenlistments. This fraction can range from zero to greater than one, but if it is greater than one, the CW with no modification is used--effectively, the fraction varies from zero to one. When the projected reenlistments are very small in relation to the number needed, the fraction is small and the resulting criticality weight points are then smaller than the original CW. When the projection is more than needed, the criticality weight points equal the CW.

g. If it is anticipated that requirements for reenlistments in some MOS/zone will be met at a given multiplier level, then a higher multiplier will not increase contributions in that MOS/zone. Without loss of optimality, the parameter values associated with such higher multiplier levels are not entered into the FMPS data file. The results of computations outlined above are illustrated in the following three tables with FY 80 data for MOS 11B, Zone A.

Table 6-1. Projected Reenlistments by Multiplier (MOS/zone)[a]

MOS/ zone (11B/A)		0	1	2	3	4	5
	Eligible	Projected reenlistment rate by multiplier					
Input	6,852	.312	.360	.408	.456	.504	.552
		Projected reenlistments by multiplier					
Output		2,138	2,467	2,796	3,125	3,453	3,782

[a]Eligible to reenlist x reenlistment rate improvement factor by multiplier.

Table 6-2. Costs of Reenlistments by Multiplier (MOS/zone)[a]

MOS/ zone (11B/A)	0	1	2	3	4	5
	Projected reenlistments by multiplier					
Input	2,138	2,467	2,796	3,125	3,453	3,782
	Individual payments by multiplier ($)					
	0	3,450	6,900	10,350	13,800	16,000
	Costs of reenlistments by multiplier ($000)					
Output	0	8,511	19,292	32,344	47,651	60,512

[a]Projected reenlistments by multiplier x individual payments by multiplier.

Table 6-3. Criticality Weight Points of Reenlistments by Multiplier (MOS/zone)[a]

MOS/ zone (11B/A)	0	1	2	3	4	5		
	Projected reenlistments by multiplier						Proj reenl rqmt	Criti-cality weight
Input								
	2,138	2,467	2,796	3,125	3,453	3,782	6,449	26.78
	Criticality weight points of reenlistments by multiplier							
Output								
	8.88	10.24	11.61	12.97	14.34	15.71		

[a]Projected reenlistments by multiplier ÷ projected reenlistments required x criticality weight.

6-5. PREPROCESSOR AND POSTPROCESSOR TO ALLOCATION

a. An SRB data base with FY 80 data was prepared with information for all the Army MOS/zones on:

(1) individual payments,

(2) eligibles,

(3) reenlistments required, and

(4) reenlistment rates.

For each MOS/zone q for which requirements for reenlistments exist, the preprocessor calculates projected reenlistments at each multiplier level, the criticality weight points of reenlistments (C_{qi}) at the multiplier level, and the bonus payments to the reenlistees (b_{qi}) at the multiplier level. These items are calculated by the formulae described in paragraph 6-4. For those MOS/zones where a positive multiplier leads to increased criticality weight points from reenlistments, the numbers represented by C_{qi} and b_{qi} are read by the preprocessor into a file in the format required by FMPS.

b. Before preparing the FMPS data file the preprocessor requires that the user specify the SRB budget (B). By specifying a budget far in excess of the amount potentially used for SRB payments, the user can determine the expenditure of SRB funds and the resulting criticality weight points equal to those occurring in the absence of a budget constraint. The user may also specify multipliers to be assigned to any MOS/zones that he selects. The funds remaining from the budget after allocating the SRB awards so designated will then be allocated to the remaining MOS/zones by FMPS. This will be done to maximize the objective function of the integer program described in paragraph 6-2.

c. The file created by the preprocessor is used by FMPS to generate a solution to the allocation problem and the solution is printed into a file in a format specified by FMPS. The postprocessor takes the output file of FMPS and combines this information with data about the MOS/zones that did not enter into the FMPS data file (because these MOS/zones did not have requirements for reenlistments or eligibles for reenlistments) and reports the following:

(1) Budget constraint

(2) Total allocated

(3) Unallocated residual

(4) Total criticality weight points

(5) Total reenlistments

For each MOS/zone the postprocessor also reports for the resulting assignment:

(6) Multiplier assigned to the MOS/zone

(7) Resulting number of reenlistments in the MOS/zone

(8) Percentage of requirements in the MOS/zone these reenlistments represent

(9) Cost of bonus payments for reenlistments in the MOS/zone

(10) The criticality weight points achieved by reenlistees in the MOS/zone

6-6. LINEAR PROGRAMING AND INTEGER PROGRAMING SRB ALLOCATIONS. This paragraph describes the relationship between linear programing and integer programing in the solution of the SRB allocation problem. Proofs and numerical examples supporting assertions in this paragraph are given in Appendix E.

a. Definitions. A solution to the problem formulated in paragraph 6-2, in which the restriction that X_{qi} be 0 or 1 is changed to $X_{qi} \geq 0$ will be called a linear programing (LP) solution to the problem. As proven in Appendix E in the LP solution of the IP SRB allocation problem generated by the simplex method not more than two variables will be noninteger. This defines "near integrality" for the purposes of the present paragraph. The LP solution modified to have the largest feasible multiplier for the MOS/zone that has noninteger values when the other multipliers are not changed will be called the LP approximate solution.

b. Potential Difference Between IP and LP Solutions

(1) Empirical Results. An experiment at the US Army Concepts Analysis Agency (CAA) with realistic numerical examples has yielded results in which the allocation derived from LP approximation is close to an optimal solution obtained by using IP. However, it is possible to construct examples in which the difference between the LP approximation and the IP optimal solution is arbitrarily large.

(2) Bound on IP Value. The following relations hold for any SRB problem:

LP value $\geq$ IP value $\geq$ LP approximate value

(3) Upper Limit for Bound. The bounds in subparagraph 6-6b(2) will depend on the cost of reenlistments and the budget available for the SRB program as well as the criticality weight points of reenlistments. An upper limit on the difference between the LP value and the LP approximate value, however can be expressed in term of the criticality weight points of bonus induced reenlistments. See Appendix E for details.

c. LP versus IP Computation Time. The length of time required to obtain the IP solution to an SRB problem is highly variable. A change in the budget amount has at times resulted in a change of the running time of the IP problem from 15 minutes to 2 hours. The LP running time has never required more than 5 minutes' time.

6-7. TEST CASE OF ALTERNATIVE SRB ALLOCATIONS

a. Alternative Allocation. The SRB allocation methodology described in paragraphs 6-2 through 6-4 was tested with the FY 80 data used by MILPERCEN in developing the FY 82 SRB Program. The results of this allocation were compared with those of MILPERCEN for two cases:

(1) No bonus award made to any MOS/zone.

(2) Allocation of an SRB budget of $143,031,000.

b. MILPERCEN Allocation Results. For FY 82 MILPERCEN projected the total number of reenlistments required as 64,167 in 330 MOSs. These reenlistments in their respective MOS/zones would have yielded a maximum criticality weight point of 14,849. Table 6-4 compares MILPERCEN projected reenlistments and calculated criticality weight points without bonuses and those with their projected SRB multipliers. Without bonus awards MILPERCEN projected that reenlistments would have been 59,460. Although this number is 93 percent of 64,167--the reenlistees required--the SRB study criticalty weight points represented by the reenlistees is 6,698 which is only 45 percent of 14,849--the criticalty weight points of all the reenlistees required. MILPERCEN bonus awards are projected by them to bring reenlistments up to 63,065 which is 98 percent of requirements. The additional reenlistments increase criticality weight points to 6,956--still only 47 percent of the 14,849 required criticality weight points. In fact, even if all eligibles reenlisted, they would not satisfy total requirements, and even the maximum allowed bonus is not projected to reenlist all the eligibles in every MOS/zone.

Table 6-4. MILPERCEN FY 82 SRB Program (330 MOSs)

Comparison item	No bonuses awarded (% requirements)		Bonuses awarded (% requirements)	
Reenlistments	59,460	(93%)	63,065	(98%)
Cost ($000)	0		143,031	
Criticality weight point	6,698	(45%)	6,956	(47%)

c. SRB Study Allocation Results. The SRB study projections of reenlistments for given bonus levels, including the zero bonus level, are in general different from those of MILPERCEN. The SRB study projected reenlistments and those of MILPERCEN are different because different estimates of effectiveness were used to make the projections of reenlistments. The SRB study projections of reenlistments and the criticality weight points resulting from no bonus awards as well as from the same budget as MILPERCEN ($143 million) for the FY 82 SRB program are given in Table 6-5.

Table 6-5. SRB Study FY 82 SRB Program (330 MOSs)

Comparison item	No bonuses awarded (% requirements)		Bonuses awarded (% requirements)	
Reenlistments	56,818	(89%)	59,707	(93%)
Cost ($000)	0		143,019	
Criticality weight points	7,095	(48%)	8,233	(55%)

d. Comparison Observations. In comparing the results of the MILPERCEN and the SRB study allocations, the following observations are made:

(1) Projected reenlistments in the individual MOS/zones at given bonus multipilers are slightly different for the two allocations.

(2) The budget allotted by MILPERCEN for SRB bonus in FY 82 was $43,031,000. The SRB study allocation under a budget restriction of $143,031,000 called for an expenditure of $143,019,000. Thus not all of the allotted budget of $143 million was allocated by the SRB study allocation.

(3) The SRB study allocation of the MILPERCEN FY 82 SRB budget projected fewer reenlistments than that of MILPERCEN, but as indicated by the larger contributions, redistributed the same budget to those MOS/zones where it was most cost effective, considering historical SRB effectiveness and criticality.

e. Relationship of Available Budget to Criticality Weight Points. Using the SRB study allocation procedure, the contributions attained for several budget levels in the interval $0 to $425 million were calculated. At a budget of $418.3 million, every MOS/zone yielded the maximum contribution available from it. Any increases in the budget beyond that value did not yield higher contributions. This total of potentially obtainable criticality weight points is 8,322 which is short of the 14,849 total required criticality weight points. Figure 6-1 graphs criticality weight points from optimal SRB allocations as a function of the budget.

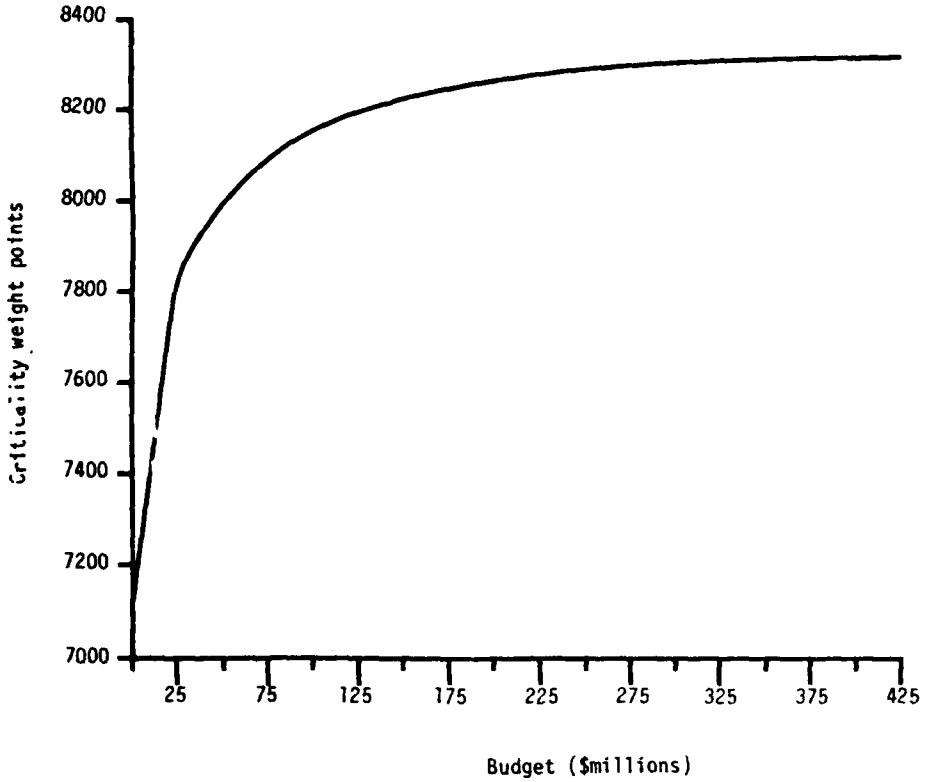

Figure 6-1. Criticality Weight Points from SRB

6-8. SUMMARY. This chapter explained the formulation of the SRB problem as an integer programing problem. The integer programing package used to solve the problem was identified and reference made to the contents of the data file used to specify the SRB problem to the programing package. The preprocessor and postprocessor developed in the SRB Study to convert data into format required by FMPS and into more user oriented output were described. Then additional information on the relationship between linear programing and integer programing in the solution of the SRB allocation problem was presented. Finally, results of a test case application of the SRB study allocation methodology were given.

CHAPTER 7

OBSERVATIONS

7-1. INTRODUCTION. The purposes of this chapter are to summarize the study results, to address the essential elements of analysis (EEA), and to state key observations.

7-2. SUMMARY. Allocation of an SRB budget using the study methodology appeared to induce more personnel in critical Army skills to reenlist than did the Army's FY 82 SRB Program as projected in May 1981. For the purpose of determining the past effect of SRB payments on reenlistment rates, 10 new skill groups were developed which represent aggregates of similar MOS. Evaluation of these groups produced positive relative effect of SRB payments on reenlistment rates as measured by the SRB regression coefficients. A methodology was developed to determine the relative utility to the Army of reenlistments in a given MOS/zone as compared to all other MOS/zones. Reenlistment utility was quantified in terms of criticality weight points. The study methodology uses the historical effect of SRB payments and MOS/zone criticality weights to allocate SRB budgets in a manner that maximizes the overall utility to the Army. Generally, the study methodology obtained total reenlistments with greater utility and at less cost than the FY 82 Program. An important consideration is that the emphasis of the study is not simply on the number of reenlistments, but on selected reenlistments that meet a definite need and make the greatest contribution to Army missions.

7-3. ESSENTIAL ELEMENTS OF ANALYSIS. The following EEAs were stated in the SRB study directive and addressed during the study period.

a. What effect have SRBs had on reenlistment rates? Multiple regression was used to explain the impact of SRB multipliers on reenlistment rates from a historical perspective. Regression analysis at the military occupational specialty (MOS) and the career management field (CMF) levels were hampered by low separation density MOSs and insufficient variation in the SRB multipliers that had been assigned. Where sufficient data existed, the bonus appeared to induce reenlistments at these levels. The most reliable evidence, however, resulted from consolidating MOSs with similar skills into 10 occupational skill groups. Skill group reenlistment rates responded positively to increases in the SRB multiplier in Zones A and B. Zone C evidence was less convincing, since personnel in the zone were first eligible for a bonus in 1980 and therefore had little opportunity to respond to the SRB.

b. What influence have exogenous variables (unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio) had on bonus induced reenlistment rates? The Consumer Price Index was positively correlated with reenlistment rates. CPI often entered the stepwise regression equation explicitly. When it did not enter the

equation explicitly, it usually did so implicitly because of its high correlation with the time variable. The time variable was always included in the regression equation because of the periodic nature of reenlistments within an annual cycle. However, since the regression equations represent skill groups and SRBs are assigned at the MOS level, the historical effect of CPI on reenlistment rates (as represented in the regression equations) could not be applied directly in the allocation methodology. The allocation methodology incorporates the effect of CPI and other external variables implicitly through the use of current reenlistment rates as the base for estimating expected reenlistment rates. The unemployment rate and the MP/CP ratio were not consistently correlated with reenlistment rates, and therefore their influence on reenlistment rates was inconclusive.

c. What are the most important selection criteria to consider when selecting an MOS for the SRB Program? Nine selection criteria were identified, with ODCSPER and MILPERCEN input, to be the most important considerations to the selection of an MOS for the SRB program. They are listed below in the order of their relative importance.

(1) Mission essentiality of the MOS.

(2) Reenlistment rate of the zone within the MOS.

(3) Reenlistment migration rate of the zone within the MOS.

(4) Percent personnel fill desired in the zone within the MOS.

(5) Percent personnel fill desired in the MOS.

(6) Replacement training cost for the zone within the MOS.

(7) Percent personnel fill of the zone within the MOS.

(8) Percent personnel fill of the MOS.

(9) Density of the MOS.

d. What kind and frequency of analysis must be performed to effectively allocate SRB funds? To correctly size and budget for the SRB program, the Army initially develops its bonus list and award levels well in advance of the actual fiscal year of payment. Therefore, frequent runs (at least quarterly) of the allocation model should be made during the interval between the first budget submission and the time when budget adjustments are no longer permitted. Some factors in the allocation model do not require frequent updates as indicated below.

(1) Criticality Weights. The criticality weights are based on the criticality selection criteria. Data for many of the criteria (i.e., percent fill, migration rate, reenlistment rate, etc.) are subject to

frequent change. These data should be updated every time the allocation model is run and not less than annually. Exceptions are replacement training cost and mission essentiality. Replacement training cost should be updated when the Military Occupational Specialty Training Cost Handbook (MOSB) is updated. Mission essentiality survey data should be valid for several years.

(2) Historical SRB Effectiveness Factors. The skill group SRB coefficients should remain valid for at least 2 years. The SRB coefficients by themselves have no time dimension. Time is invoked by applying the appropriate group coefficient to the current MOS reenlistment rate.

(3) Other Factors. Other inputs to the allocation model, such as the number of reenlistments required, the eligibles, the average SRB payment per reenlistment, and the current reenlistment rate and SRB multiplier, must be updated each time the allocation model is run.

e. What kinds of data will be needed to use the proposed SRB methodology? Principal inputs to the proposed methodology are:

(1) Historical measures of SRB effectiveness (skill group SRB coefficients).

(2) Assessments of the relative importance to the Army of reenlistments in Army skills (as represented by the MOS/zone criticality weights).

(3) Current MOS/zone information such as:

(a) Reenlistments required.

(b) Eligibles.

(c) Reenlistment rate and SRB multiplier.

(d) Average SRB payment per reenlistment.

These inputs are integrated to produce the costs and the criticality weight points associated with the expected reenlistments at each multiplier level of each MOS/zone. The allocation model makes tradeoffs between these costs and criticality weight points to produce the optimal SRB allocation.

f. What data not currently available must be gathered so that the proposed methodology can be implemented? All data required to implement the proposed methodology are currently available, although these data may not be integrated and automated in the required format. To implement the proposed methodology, emphasis should be placed on acquiring automated data sources. Particular data-related problems encountered during the development of this methodology were as follows:

(1) Lack of a readily available source of automated reenlistment and SRB history with corresponding migration history for the SRB effectiveness analysis.

(2) Lack of reliable crosswalks between military skills and civilian skills for the purpose of examining the impact of external influences (economy, pay comparability and unemployment) on reenlistment decisions.

(3) In the absence of viable alternatives, many of the data inputs to support development of the criticality and allocation methodologies were taken from the Army's proposed SRB Program as submitted to OSD in May 1981. Future efforts should focus on the development of an automated source of these data, namely, the selection criteria elements, reenlistments required, eligibles and current reenlistment rates.

g. What time span should the data cover? The appropriate time span for data will depend on the particular part of the methodology concerned.

(1) At least 5 years of historical observations are necessary to evaluate SRB effectiveness.

(2) Criticality weight computations may be based on 1 year of data for selection criteria attributes or on attribute data that span several years. SRB study criticality weights represent 1 year (FY 81) of attribute data due to the limited availability of automated data.

(3) Current MOS/zone information such as projected eligibles, reenlistments required, reenlistment rate, etc., should be observed as closely as possible to the time period that the SRB allocation projection is to represent.

7-4. KEY OBSERVATIONS. The key observations resulting from this study are:

a. Evaluation of historical reenlistment data revealed limited positive correlation between SRB levels and reenlistment rates by either MOS or CMF groups.

b. For study purposes, 10 new skill groups were developed which aggregate similar skills horizontally across existing MOS/CMF groups; evaluation produced positive correlation between SRB payments and reenlistment rates, using these new skill groups.

c. The national unemployment rate and the ratio of military pay to civilian pay did not appear to have any consistent influence on projecting reenlistment rates.

d. The application of the SRB allocation methodology developed in this study appears to provide a higher level of effectiveness (measured in projected critical skill reenlistments) for a given SRB budget than did the current Army SRB allocation methodology.

e. The concept of criticality weights provides a useful tool for determining the relative importance of reenlistments in a specified MOS/zone as compared to all other MOS/zones. However, the value of the criticality weight is very sensitive to the selection of the attributes used in its determination.

f. The SRB allocation methodology produces significantly different results depending on whether the criticality weight is assigned as the utility of the required reenlistments in the MOS/zone or as the utility of each reenlistment in the MOS/zone.

g. Several vital MOSs appear insensitive to the concept of an SRB bonus, regardless of level; a nonmonetary incentive may be needed to supplement the effect of the SRB bonus in inducing reenlistments in these few vital skills.

7-5. LIMITATIONS. Limitations of the SRB study methodology were mostly data related and they are summarized below.

a. Normal data fluctuations within individual MOSs made it impossible to determine the historical effect of SRB payments on reenlistment rates at the MOS level of detail. Only when MOS data were consolidated (10 skill groups were used in this study) was there a sufficient basis for statistical analysis of the SRB effect on reenlistment rates.

b. Consolidating MOS data into skill groups produced reliable estimates of SRB effect on the reenlistment rates of personnel serving in Zone A and Zone B. Since Zone C personnel had been eligible for the SRB for only 1 1/2 years, the study lacked a 5-year data base for the group.

c. Estimates of SRB effect for nine skill groups in Zone C were based on the experience of the intelligence group, the only group with historical statistical results in Zone C. While this result was not statistically significant it was considered preferable to totally excluding all Zone C MOSs from the allocation methodology. In addition, it was determined that the allocation model was not very sensitive to small changes in Zone C SRB coefficients. This is true because of the high reenlistment propensity (generally 80 percent to 95 percent reenlistment rate without a bonus) of Zone C personnel.

d. A quantifiable methodology (and data to a lesser degree) which permits the various MOS/zones to be prioritized for bonus considerations did not exist prior to this study. For this reason, subject matter experts were surveyed to determine the most important factors to be considered when assigning a bonus to an MOS as well as the relative importance of each factor. Responses to the survey were transformed into criticality weight point assessment for each MOS/zone. Because the survey was not replicated, it is impossible to assess the reliability of survey responses and, consequently, the resulting criticality weight points assigned to an MOS. An additional limitation resulted from the subjective (albeit consistent) methodology used in the transformation of survey response into critical weight points. Analysis revealed that certain combinations of factors may mitigate the expected dominance of any one factor.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

   a. Study Directors

      LTC Harlan J. Lenius, Requirements Directorate
      Ms Ola C. Berry

   b. Team Members

      Mr. Joel Levy
      CPT(P) Joseph P. Seletsky

   c. Other Contributors

      Mr. Carl B. Bates, Methodology and Computer Support Directorate
      Mr. Steve Bravy, Methodology and Computer Support Directorate
      Mr. Bret Graham, Methodology and Computer Support Directorate
      CPT August C. Manguso, Methodology and Computer Support Directorate

2. EXTERNAL CONTRIBUTOR

      Mr. Robert Mayfield, US Army Military Personnel Center

APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR PERSONNEL
WASHINGTON, DC 20310

REPLY TO ATTENTION OF

17 SEP 1981

DAPE-MPR-RE

SUBJECT: Selective Reenlistment Bonus (SRB) Study

Commander
US Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

1. PURPOSE OF STUDY DIRECTIVE. This directive provides for the establishment of a study group to develop an improved methodology for allocation of Selective Reenlistment Bonus (SRB) funds. An associated purpose is to analyze the historical effectiveness of SRBs.

2. STUDY TITLE. Selective Reenlistment Bonus (SRB) Study.

3. BACKGROUND. Selective Reenlistment Bonuses are paid to Army personnel who are serving in and reenlist in designated military occupational specialties (MOS) that are experiencing retention levels insufficient to sustain the force. Factors considered in determining which MOS should be authorized an SRB are: retention objective, career manning level, training investment, and essentiality to the defense mission. The funds for the payment of SRBs are constrained; therefore, the Army must ensure that the available funds are allocated to those MOSs which have the greatest need for retention incentives and that the bonuses are cost effective in retaining personnel.

4. STUDY SPONSOR. Office of the Deputy Chief of Staff for Personnel (ODCSPER).

5. STUDY AGENCY. US Army Concepts Analysis Agency (CAA).

6. TERMS OF REFERENCE

a. Problem. The current method of determining MOSs to receive SRBs and of designating award levels is a subjective analysis, using manual procedures, without assurances that the bonuses offered are to skills having the greatest need and are effective for these skills. This is inadequate for a program which makes SRB payments in excess of $120 million annually and which is marked to grow to $220 million by FY 87.

b. Purpose. The study will develop a formalized methodology for more effective allocation of SRB funds. It will also analyze the historical effectiveness of SRBs.

DAPE-MPR-RE 17 SEP 1981
SUBJECT: Selective Reenlistment Bonus (SRB) Study

c. Objectives

(1) Determine the past effect of SRBs on reenlistment rates.

(2) Examine the impact of exogenous variables, such as unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio, on bonus induced reenlistment rates. Identify those exogenous variables which have had a significant influence upon reenlistment rates.

(3) Select parameters to identify and rank candidate MOSs, and establish criteria to determine which are critical to the defense mission and should be candidates for award of an SRB.

(4) Determine the kind and frequency of analysis that must be made to allocate SRB funds more effectively.

(5) Develop the methodology for allocation of SRB funds to the point where the study sponsor will be able to utilize an automatic data processing (ADP) system for implementation.

d. Scope. The study will encompass a review of current directives and procedures governing the SRB Program and the development of a methodology to more effectively allocate SRB funds.

e. Limitations: It is not anticipated that the study will:

(1) Address the effectiveness of other programs or policies designed to alleviate MOS shortfalls.

(2) Develop and evaluate alternatives to the SRB Program.

(3) Evaluate the impact on quality of personnel retained.

f. Constraints. A final study report will be provided to the study sponsor on 15 July 1982.

g. Timeframe. Current.

h. Assumptions

(1) Certain MOSs are more critical to accomplishment of the defense mission than others.

(2) A combination of factors, e.g., reenlistment rates, career manning levels, training irvestments, criticality to the defense mission, etc., determine the need for an SRB for an MOS.

(3) Existing data to allow an analysis of the relationship between SRBs and reenlistments are available and sufficient.

(4) The cost factors in the Military Occupational Specialty Training Cost Handbook are valid for training cost data.

(5) The US Army Military Personnel Center (MILPERCEN) methodology for projecting personnel shortfalls by MOS is acceptable.

(6) The MILPERCEN reenlistment forecast methodology is an acceptable tool for projecting reenlistment data.

(7) The Army will continue to pay SRBs.

(8) The funds available to pay SRBs will remain constrained.

(9) A peacetime environment will continue.

i. Essential Elements of Analysis (EEA)

(1) What effect have SRBs had on reenlistment rates?

(2) What influence have exogenous variables (unemployment rate, Consumer Price Index (CPI), and military pay/civilian pay (MP/CP) ratio) had on bonus induced reenlistment rates?

(3) What are the most important selection criteria to consider when selecting an MOS for the SRB Program?

(4) What kind and frequency of analysis must be performed to effectively allocate SRB funds.

(5) What kinds of data will be needed to use the proposed SRB methodology?

(6) What data not currently available must be gathered so that the proposed methodology can be implemented? What time span should the data cover?

j. Environmental Impact. No environmental consequences are envisioned; however, the study agency is required to surface and address any environmental considerations that develop in the course of the study effort.

k. Estimated Cost Savings. There are potentially significant cost avoidances for reenlistees vice recruiting and training new personnel.

7. RESPONSIBILITIES

a. The ODCSPER will:

(1) Provide a study coordinator.

(2) Establish and chair a study advisory group (SAG) and convene meetings.

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(3) Provide a list of points of contact (POC) at Department of Defense (DOD); Headquarters, Department of the Army (HQDA); major Army commands (MACOM); and other agencies as appropriate.

(4) Furnish available SRB and reenlistment data, reenlistment projections, and MOS and personnel information to CAA as requested. If data are late or inadequate, adjust study schedule and/or scope accordingly.

b. Specified HQDA staff offices, MACOMs, and other agencies will:

(1) Designate a POC.

(2) Participate in SAG meetings.

(3) Provide input concerning SRB Program policies, procedures, capabilities, and requirements as requested by ODCSPER or CAA.

c. CAA will:

(1) Designate a study director and establish a full-time study team.

(2) Establish direct communications with HQDA, MACOMs, and other agencies as required for the conduct of the study.

(3) Provide periodic in-process reviews (IPR) and provide a final study report to the study sponsor.

(4) Provide programing and ADP support as required for the conduct of the study.

8. LITERATURE SEARCH

a. The following organizations will have responsibility for, or interest in, the subject matter of the study:

(1) Office of Management and Budget (OMB).

(2) General Accounting Office (GAO)

(3) Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics (OASD (MRA&L)).

(4) Office of the Assistant Secretary of the Army for Manpower and Reserve Affairs (OASA (M&RA)).

(5) Department of the Army Staff (ARSTAF).

(6) MACOMs.

(7) MILPERCEN.

b. The following past studies are related to the issue:

(1) Cost Effectiveness Analysis of Enlistment/Reenlistment Bonuses, Volume 1, The Enlistment Bonus, CAA Study Report 74-19, Nov 74.

(2) Management of Enlisted Bonus Recipients (MAEBR), CAA Study Report 75-8, Jul 75.

(3) Derivation of MOS-Unique Continuation Rates, CAA Technical Paper 77-3, Apr 77.

(4) Cost Effectiveness Analysis of Bonuses and Reenlistment Policies (CEABREP), CAA Study Report 77-10, Aug 77.

(5) First Term Reenlistment Projection of Military Occupational Specialty (1-RPM), CAA Study Report 79-5, Apr 79.

9. REFERENCES:

a. Administrative

(1) AR 5-5, The Army Study Program, Jul 77.

(2) DA Pam 5-5, Guidance for Study Sponsors and Study Advisory Groups, Oct 76.

b. Substantive

(1) DOD Directive 1304.21, Award of Enlisted Personnel Bonuses and Proficiency Pay, Jul 78.

(2) DOD Instruction 1304.22, Administration of Enlisted Personnel Bonus and Proficiency Pay Programs, Oct 78.

(3) AR 600-200, Enlisted Personnel Management System, Jan 81.

(4) AR 611-201, Enlisted Career Management Field and Military Occupational Specialties, Oct 73.

(5) DA Cir 611-73, Announcement of Proficiency Pay/Selective Reenlistment Bonus/Enlistment Bonus/Career Progression MOS/Comparable MOS for Bonus Recipients, Aug 79.

(6) DA Cir 611-81-4, Career Management of the Enlisted Force, May 81.

(7) Military Occupational Specialty Training Cost Handbook (MOSB), Comptroller of the Army, Sep 80.

(8) Audit of the Army Bonus Program, US Army Audit Agency, Report HQ 80-210, Sep 80.

(9) The Use of Reenlistment Bonuses, Center for Naval Analysis, May 75.

(10) The Nuclear-Trained Petty Officer Continuation Bonus: First Year's Experience - Executive Summary, Rand Corporation, Aug 74.

(11) Effect of the Variable Reenlistment Bonus on Reenlistment Rates: Empirical Results for FY 1971, Rand Corporation, Jun 75.

(12) Reservation Wages and Military Reenlistments, Rand Corporation, Feb 76.

(13) Reenlistment Bonuses and First-Term Retention, Rand Corporation, Sep 77.

10. ADMINISTRATION

a. Support

(1) Funding for temporary duty (TDY) and travel associated with the study will be provided by each participating agency.

(2) Automatic data processing equipment (ADPE) will be provided by CAA.

b. Milestone Schedule

First IPR/SAG	Oct 81
Second IPR/SAG	Feb 82
Final SAG	Jun 82
Final report published	Jul 82

c. Control Procedures

(1) The ODCSPER will convene a SAG and provide a chairman for the group. Periodic IPRs will be provided to the SAG by the study team.

(2) The ODCSPER study coordinator will provide guidance to the study, satisfy reporting requirements of AR 5-5, and distribute the final report.

d. Action Document. A final study report will be published and copies provided the study sponsor.

DAPE-MPR-RE
SUBJECT: Selective Reenlistment Bonus (SRB) Study

e. Coordination. This tasking directive has been coordinated with CAA in accordance with AR 10-38.

FOR THE DEPUTY CHIEF OF STAFF FOR PERSONNEL:

Elden H. Wright

ELDEN H. WRIGHT
Colonel, GS
Deputy Director of Military
Personnel Management

APPENDIX C

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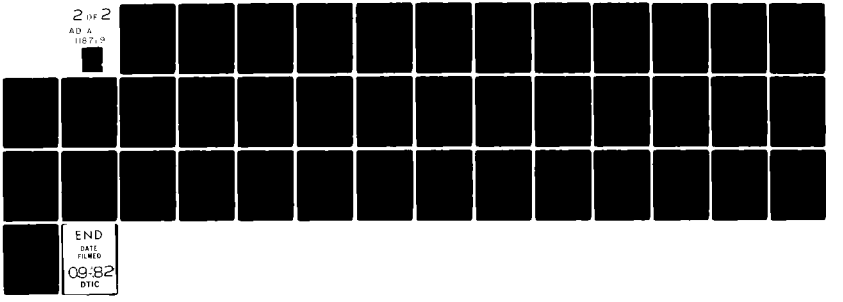

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APPENDIX D

SRB MODEL DOCUMENTATION

D-1. INTRODUCTION. The primary task of the Selective Reenlistment Bonus (SRB) Study was to develop a methodology to allocate an SRB budget to military occupational specialty (MOS) reenlistment zones of eligibility in the most cost effective manner. To do this, a methodology was developed that projected the number of reenlistments, by multiplier, for each MOS/zone as well as the costs and criticality weight points associated with the reenlistments by multiplier. This methodology included a model that evaluated the past effectiveness of the SRB, a model that developed a criticality weight for each MOS/zone, and an allocation model. An overview of the methodology is shown in Figure D-1. The criticality weight is the basis for rank-ordering the MOS/zone for the purposes of deciding which should receive a bonus. The costs and criticality weights for all MOS/zones were then used in the Mixed Integer Program of the Functional Mathematical Programming System (MIP-FMPS) which compared these costs and criticality weights and found the optimal allocation of funds within the established budget constraint. For each MOS/zone, the output consisted of the SRB multiplier assigned, the reenlistments associated with that multiplier, and the cost and criticality weight associated with those reenlistments. Detailed discussions of each major submodel in the methodology follow.

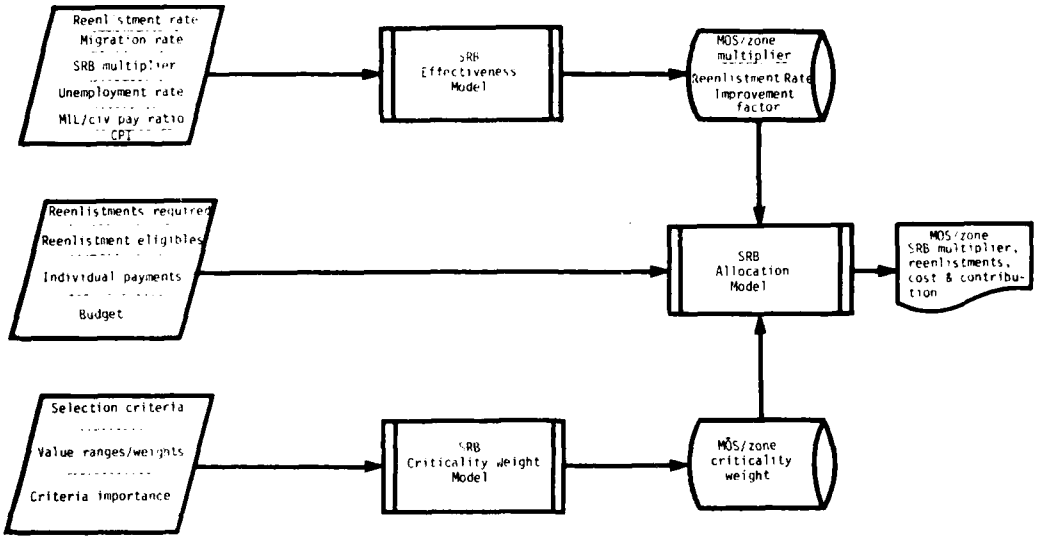

Figure D-1. SRB Model Methodology

D-2. SELECTIVE REENLISTMENT BONUS EFFECTIVENESS MODEL (SRBEM). This paragraph provides a brief discussion of the processing necessary to derive historical measures of the effect that SRB payments have had on the reenlistment decisions of enlisted Army personnel.

a. Model Overview. The SRBEM is a collection of independent functional programs that produce quantitative estimates of the change in the reenlistment rate given a change in SRB multiplier. Figure D-2 provides an overview of the major functions within the model and shows how the various functional programs are interrelated. The major functions performed are (1) data integration, (2) graphical analysis, and (3) statistical analysis.

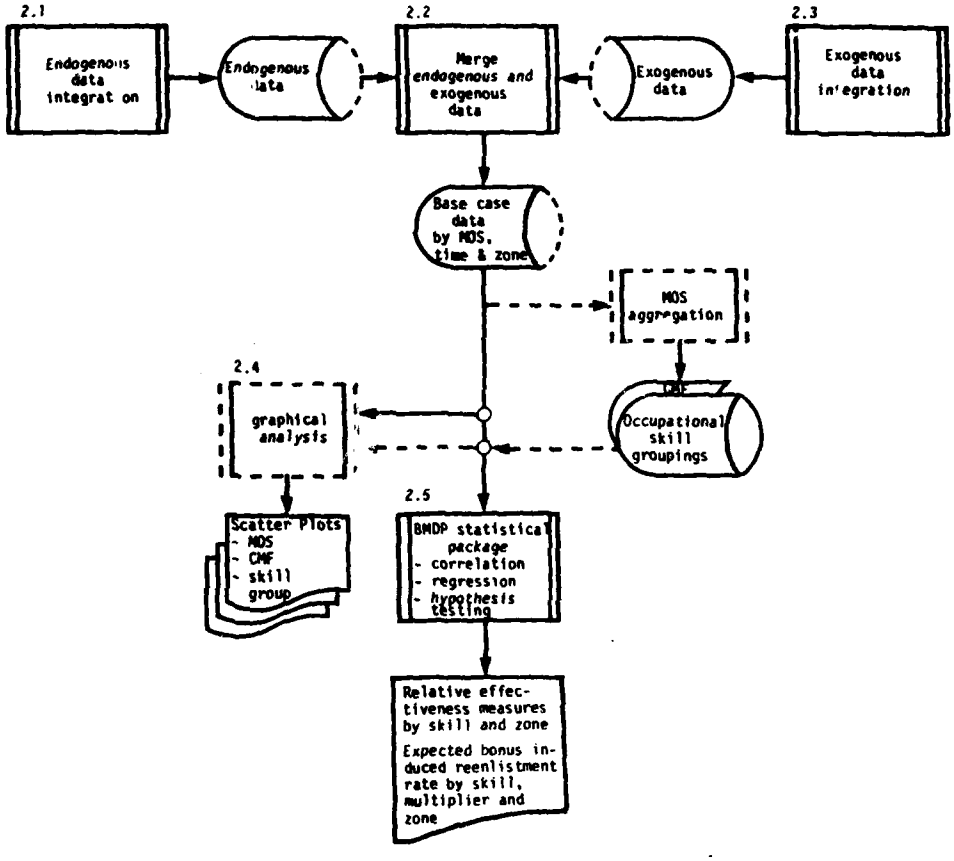

Figure D-2. SRB Effectiveness Model

b. Environment. The SRBEM software was written and operated on the UNIVAC 1100/82 computer with the following exceptions·

(1) Graphical capability was written on the UNIVAC 1100/82 to operate on the Tektronic 4081 Graphics System.

(2) Statistical capability was provided by the Biomedical Statistical Software Package (BMDP).

Programs written on the UNIVAC 1100/82 were in American Standard Code for Information Interchange (ASCII) FORTRAN, level 9R1.

c. Model Logic. Discussion of each of the major functional programs follows. An exception is the BMDP statistical package. The user is referred to BMDP documentation if further information is desired on this package.

(1) Endogenous Data Integration. Processing of the endogenous variables (reenlistment rates, migration rate, and SRB multipliers) involves data entry, data integration, and provisions for efficient data storage and retrieval. Figure D-3 is a representation of this process. It identifies the four types of inputs, namely, (1) magnetic tape copies of Department of the Army Personnel Center 120 Reports (DAPC-120) containing historical reenlistment data, (2) history of SRB multipliers assigned (hard copy), (3) MOS/career management field (CMF) structure (hard copy), and (4) tape copy of migration data. Highlights of the major functions performed on each type of input are summarized below. The narrative relates the description to the program element number (PEN) where the task is performed.

(a) Reenlistment History. The XTRACTOR (2.11) program obtains pertinent information from the DAPC-120 tapes and stores it on disc. Data for each year of service was not important to the study; therefore, only data by reenlistment zone of eligibility were extracted. The data were sorted (2.12) for ease of subsequent processing.

(b) SRB History. Program BLDBONUSFILE (2.13) accepts manual SRB historical multipliers and translates them to computational form on disc for subsequent integration within the Army structure. Program BLDMOSID (2.17) provides disk storage of the Army MOS/CMF structure which was a hard copy input. These two sources of data are then integrated and stored within program ADDSRBCMF (2.14) which provides direct access to historical SRB multipliers identified by MOS and CMF.

(c) Migration History. Primary duties performed are those of converting data from tape to disc and computing average migration rates for each MOS for which there is history (2.16).

(d) Data Merge and Extract. All endogenous data are brought together within this area of the program (2.15). The output consists of three disc files containing endogenous data for each of the three reenlistment zones of eligibility.

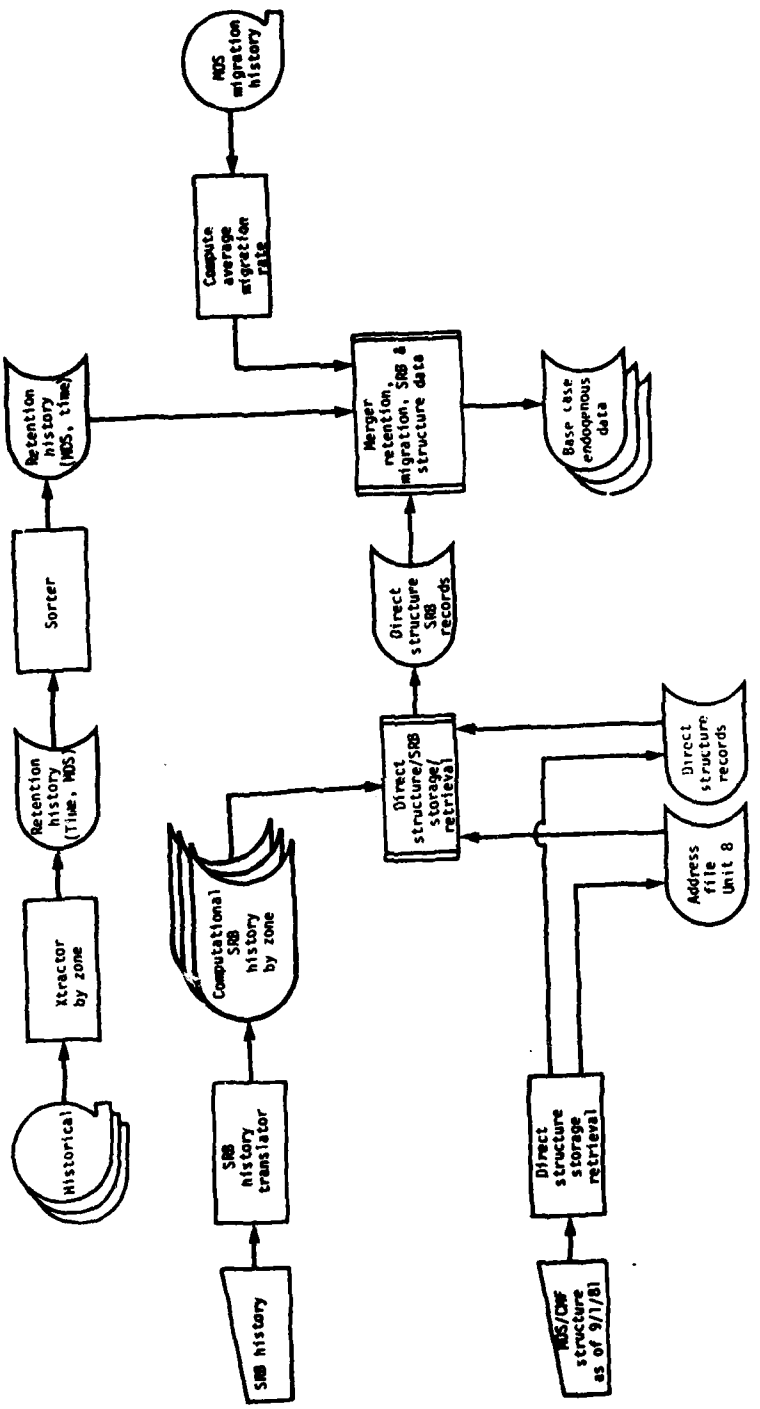

Figure D-3. Endogenous Data Inputs, Processing, and Integration

(2) Exogenous Data Integration. Processing of exogenous variables involves entry of civilian and military earnings and the Consumer Price Index (CPI) from hard copy sources, and the transfer of unemployment history from tape to disc storage. The military pay to civilian pay (MP/CP) ratio was computed and integrated with the CPI and unemployment rates. This integration formed three files of monthly exogenous variables by MOS and zone for the period studied.

(3) Endogenous and Exogenous Integration. Exogenous data were converted from monthly to quarterly observations and merged with the endogenous data. The result was three zone-unique files of the data base for effectiveness analysis. Query routines were written to extract skill-unique data for up to 18 skills during an execution and to write the data for each skill to a unique file. User options specified whether the skill level desired was to be an MOS or a CMF. Files created by these routines were direct inputs to the graphics system and the BMDP statistical package.

(4) Graphics System. Programs were written to produce scatter plots of skill-specific data. Plots at the MOS level of detail include the exogenous trends. At the CMF level, the exogenous trends are omitted to prevent the charts from becoming too busy. CMF plots were generally busier due to several SRB multipliers assigned during a quarter, since the CMF is a consolidation of history for many MOSs. The graphics system is interactive, has an input correction feature, and accepts multiple plot requests.

D-3. SELECTIVE REENLISTMENT BONUS CRITICALITY WEIGHT MODEL (SRBCWM). This program and accompanying subroutines were developed to provide support for the pre and postprocessors associated with the SRB allocation model. It was written and tested on the UNIVAC 1100/82 computer, in ASCII FORTRAN, level 9R1. The program is designed to be interactive with a terminal operating in the demand mode. As such, it requires both manual and automated data input. Once initialized, a formatted direct access file is used to store all data required to calculate the criticality weights (CW). This file, coupled with its particular addressing routine, is capable of providing a specific address for data belonging to any MOS/zone ranging from 00A/A through 99Z/C. Figure D-4 graphically depicts the flow of the program as it builds the criticality weight file.

a. Input

(1) Data inputs for categories 1 (percent of fill of the zone), 2 (percent of fill of the MOS), 3 (reenlistment rate of the zone), 4 (reenlistment migration rate of the zone), and 7 (density of the MOS) are available from the existing MILPERCEN data base. All data derived must be from the same time period.

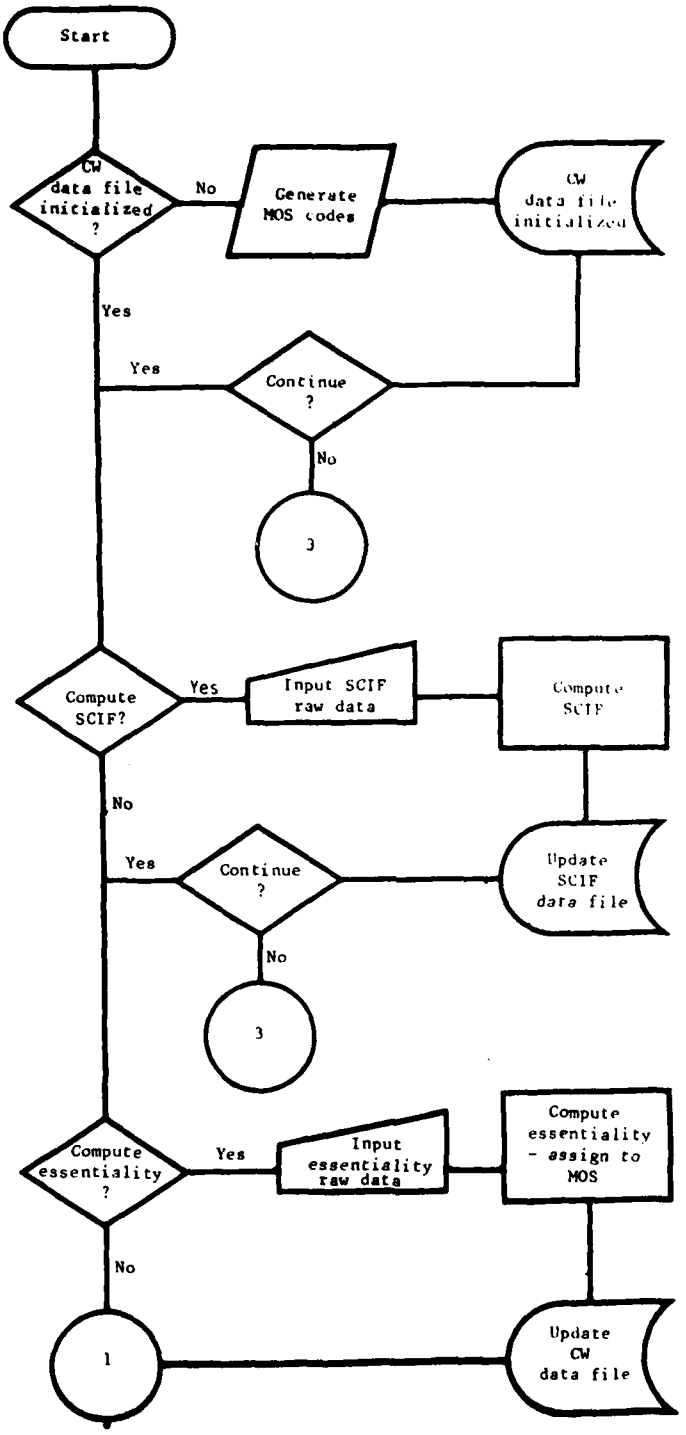

Figure D-4. SRB Criticality Weight Model (SRBCWM) Flow Chart
(page 1 of 2 pages)

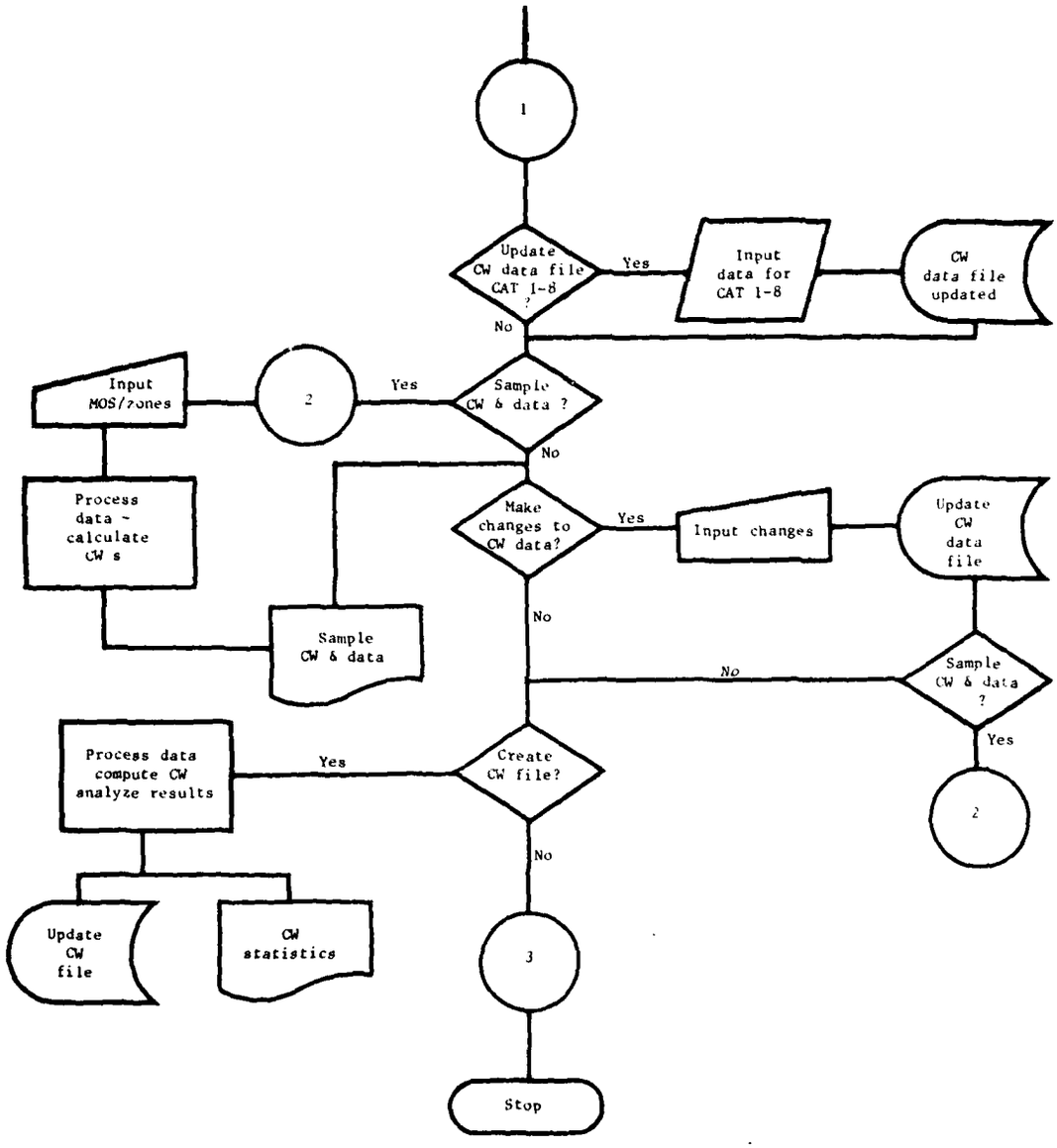

Figure D-4. SRB Criticality Weight Model (SRBCWM) Flow Chart
(page 2 of 2 pages)

(2) In the case of categories 5 (percent of personnel fill desired in the zone) and 6 (percent of personnel fill desired in the MOS), a 100 percent fil is assigned. Should these assignments or any other portion of the data need to be changed, provisions have been made in the program whereby data associated with any MOS/zone can easily be manually modified.

(3) Data for category 8 (replacement training costs for the zone) were obtained from an automated version of the Military Occupational Speciality Training Cost Handbook (MOSB) available from the Office of the Comptroller. This information was transferred from a sequential to direct access file via a binary search routine. A similar routine was used later to provide the information to the CW data file.

(4) Data for category 9 (mission essentiality) is provided via the essentiality computation routines and is assigned directly to the MOS/zones.

(5) The selection criteria importance factors (SCIF) are derived by the appropriate computational routines and stored in the SCIF data file.

(6) The addressing and binary search routines require a sequential file of MOS codes arranged in ascending order. This file must contain all the MOSs which need a CW assigned It must also have, matched to the MOS code, the appropriate skill group number. In the event that an MOS is new to the inventory and possesses no or only partial historical data, the annotation of the skill group number will ensure that the program is able to provide the skill group average for all categories that are missing data.

b. Output. Output from the program will only be provided upon demand. This output can take two basic forms:

(1) Sample CWs along with a display of associated raw data, criticality selection criteria value weights (CSCVW) adjusted by the SCIF, will be provided for any MOS/zone requested.

(2) The criticality weight file will be listed in ascending MOS/zone order. In addition, a display of selected statistics will be provided. These will include the mean, the standard deviation, the variance, the distribution, and the degree of skewness.

D-4. SELECTIVE REENLISTMENT BONUS ALLOCATION MODEL (SRBAM). The outputs from the SRBEM and the SRBCWM in conjunction with a preprocessor, the MIP-FMPS Program and the postprocessor form the SRBAM.

a. Preprocessor (PREP). The preprocessor SRB (PREP) for the allocation model consists of two ASCII FORTRAN programs (level 9R1) that operate on the UNIVAC 1100/82 computer. Collectively, PREP is the means by which the many influences on SRB allocations are integrated and consolidated into the key measures (costs and criticality weights) that the optimization program evaluates. An overview of the PREP is shown in Figure D-5. The first program (Input Consolidator) is responsible for obtaining data for the various influences and any consolidation that is required. The second program (Input Transcriber) provides the automated link between these influences and the Functional Mathematical Programming System (FMPS) in the format that FMPS requires. This program also includes optional features which tailor the allocation process to the needs of the user. Further discussion of each program follows.

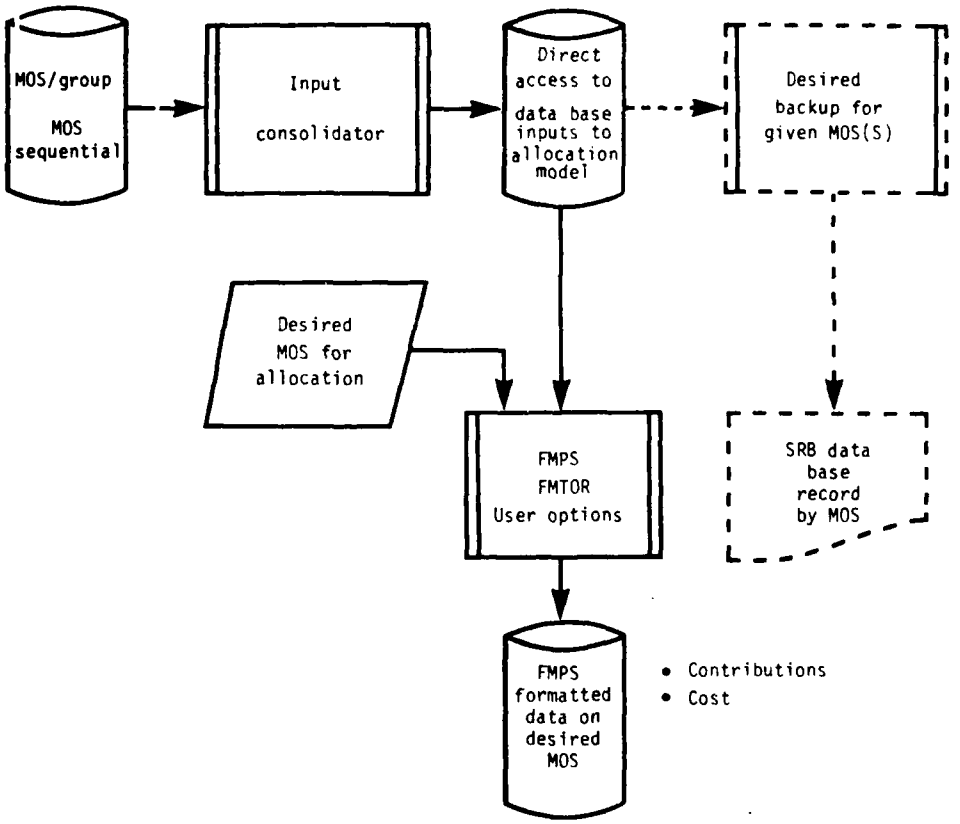

Figure D-5. SRB Preprocessor (PREP) for the Allocation Model

(1) Input Consolidator. This is a modular program which collects data for each factor considered in the allocation process, stores the data with direct retrieval capability and provides for its subsequent retrieval. The collection of data is referred to as the selected reenlistment bonus data base (SRBDB). The SRBDB contains the elements of data that are shown in Table D-1 for each MOS. Direct retrieval from the SRBDB is provided through a binary search algorithm which ensures a rapid response capability. The program consists of ten functional subroutines as described in Figure D-6. This modularity should make it easier for future users to modify the program to accommodate different input data sources.

(2) Input Transcriber. Using the binary search algorithm mentioned above, this program retrieves the necessary information for each MOS/zone. It then determines the amount of information which is appropriate for inclusion in the FMPS data file. This information is then written to the FMPS data file in the required format. It should be noted that this program is designed to be interactive with a terminal and requires certain inputs from the terminal. These are:

(a) Total budget constraint.

(b) Name of the file.

(c) What (if any) MOS and zone are to be held constant at a given multipler.

b. SRBAM Parameters. The parameters needed for SRBAM are of three types:

C_{qi} - the criticality weight points of total reenlistees in MOS/zone q when bonus multiplier is i (the criticality weight points concept was developed by the SRB Study as a means of quantifying the contribution of reenlistments to the Army mission as measured by criticality weights)

b_{qi} - the cost of the total bonus payments made to reenlistees in MOS/zone q when bonus multiplier is i

B - budget assigned to make reenlistment bonus payments.

The numbers indicated by these parameters are in the data file which is accessed by FMPS. The size of B is a policy decision.

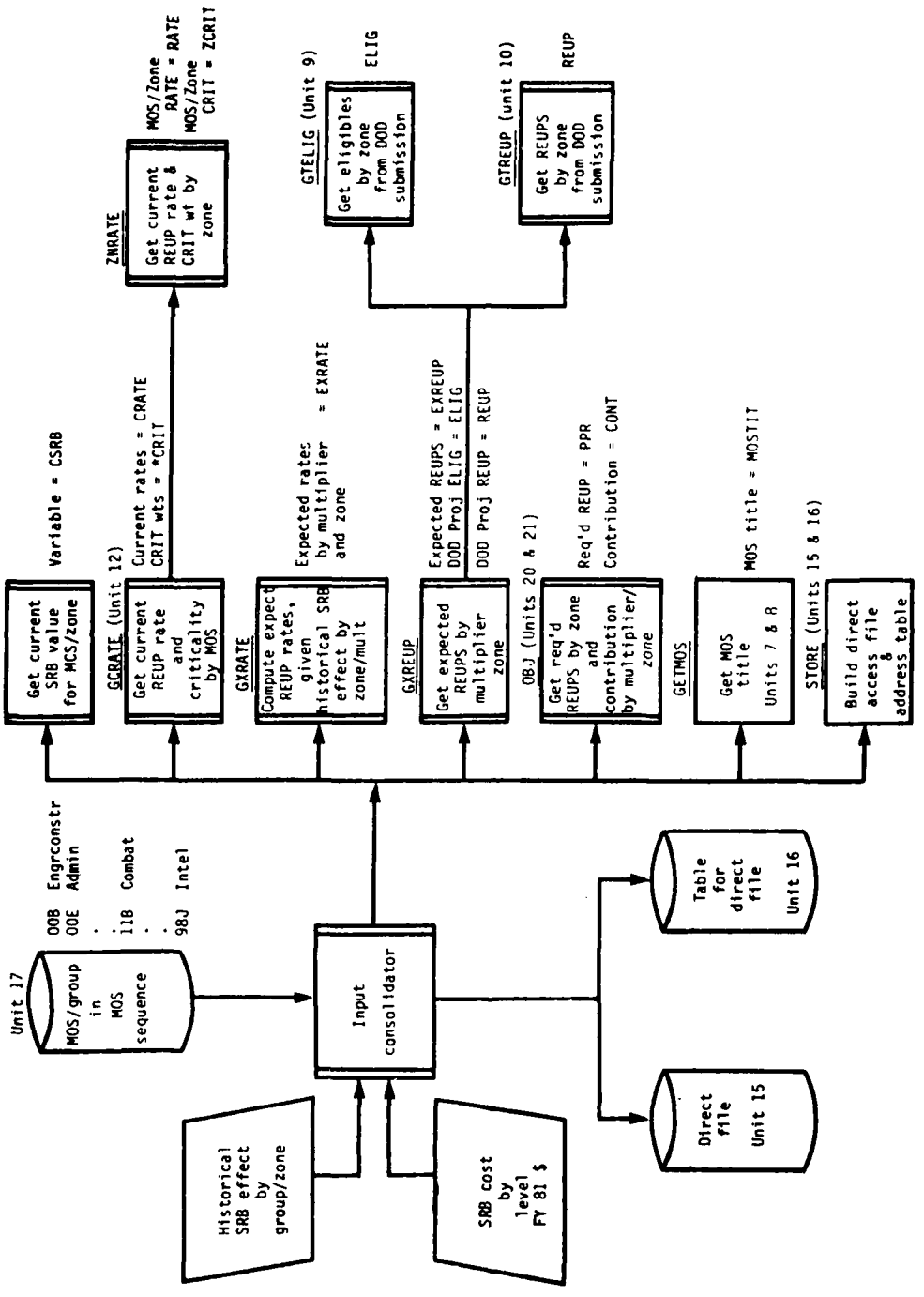

Figure D-6. SRB Input Consolidator

Table D-1. SRB Data Base (SRBDB) Contents for MOS 11B

MOS: 11B INFANTRYMAN GROUP ID : DIRCRT

ZONE	REQD REUPS	ELIGS	CURRENT SRB	CURRENT REUP RATE	SRB EFFECT	CRITICALITY
A	6449.	6852	1	.3600	.048	26.78
B	820.	1200	C	.6400	.054	23.30
C	723.	715	D	.9300	.059	21.37

EXPECTED REENLISTMENT RATE

ZONE	0	1	2	3	4	5	6
A	.3120	.3600	.4080	.4560	.5040	.5520	.5520
B	.6400	.6980	.7480	.8020	.8560	.8560	.8560
C	.9300	.9890	1.0000	1.0000	1.0000	1.0000	1.0000

EXPECTED REENLISTMENTS

ZONE	0	1	2	3	4	5	6
A	2138.	2467.	2796.	3125.	3453.	3782.	3782.
B	768.	833.	898.	962.	1027.	1027.	1027.
C	665.	707.	715.	715.	715.	715.	715.

$ PAYMENT BY SRB MULTIPLIER

ZONE	0	1	2	3	4	5	6
A	0.	3450.	6900.	10350.	13800.	16000.	16000.
B	0.	4200.	8400.	12600.	16000.	16000.	16000.
C	0.	4925.	9850.	14775.	16000.	16000.	16000.

EXPECTED COST BY MULTIPLIER

ZONE	0	1	2	3	4	5	6
A	0.	8510184.	19289750.	32338699.	47657029.	68516863.	60516863.
B	0.	3497760.	7539840.	12126240.	16435200.	16435200.	16435200.
C	0.	3482640.	7042750.	10564125.	11440000.	11440000.	11440000.

CONTRIBUTION BY MULTIPLIER

ZONE	0	1	2	3	4	5	6
A	8.88	10.24	11.61	12.97	14.34	15.71	15.71
B	23.30	23.30	23.30	23.30	23.30	23.30	23.30
C	19.65	20.90	21.13	21.13	21.13	21.13	21.13

(1) The values of C_{qi} and b_{qi} are derived from the effectiveness coefficients and the criticality weights (CW), respectively. The following additional data, available from MILPERCEN, are also required for each MOS/zone:

(a) The number of persons eligible to reenlist.

(b) The requirements for reenlistments.

(c) The monthly pay per individual to which the multiplier will be applied and the number of years of the reenlistment. A limitation of $16,000 on individual reenlistment bonus payments must also be taken into account.

(2) The bonus payment at multiplier i for MOS/zone q will be i times the reenlistee's monthly basic pay times the number of years for which the reenlistment is made. No multiplier is assigned to an MOS/zone such that the resulting value calculated above would be in excess of $16,000.

(3) Reenlistments per MOS/zone are calculated from the equivalent of the following. The anticipated reenlistments are the smaller of:

(a) Reenlistments with no bonus + i (increments in reenlistments per unit of multiplier).

(b) Eligibles.

(4) From this costs are computed b_{qi} = (individual bonus payments at multiplier i for MOS/zone q) x (reenlistments at multiplier i for MOS/zone q).

(5) Criticality weight points (C_{qi}) are calculated only for MOS/zones for which a requirement for reenlistments exists. In such a case, C_{qi} is evaluated as the smaller of:

(a) $\dfrac{\text{reenl at mult i for MOS/zone q}}{\text{rqmts for reenl MOS/zone q}}$ x CW of MOS/zone q

(b) CW of MOS/zone q.

c. MIP-FMPS Execution. The parameters listed in paragraph D-4b are entered by the preprocessor into a data file in format appropriate for FMPS. A typical program to perform the allocation by MIP-FMPS for a size problem of about two to three hundred MOS/zone is given in Table D-2.

Table D-2. Sample MIP-FMPS Program

```
      ASSIGN 100 TO KINV
      ASSIGN 200 TO KFREQA
      ASSIGN 300 TO KNFS
      ASSIGN 400 TO KIOER
      ASSIGN 500 TO KMINER
      ASSIGN 600 TO KMAJER
      CALL ENTER(MIP)
      FOBJWT=-1.0
      FMIACC=.000001
      IFMONODE=30000
      ILOGMIP=-1
      IBRNFRLO=0
      IZTABSZ=120000
      IMAXFMPS=230000
      IMAXSPRM=230000
      CALL CORE(FMPS,230000)
      CALL CORE(SPRINT,230000)
      CALL INPUT
      ADATA='LIST'
      CALL LOAD(LIST(LISTINI))
      CALL IORDER
      CALL ISOLVE(NOSCALE,NOREDUCE)
      ILINES=75
      CALL MIPSOLN(ACTIVE)
      STOP
100   AWERR='KINV'
      GOTO 1000
200   AWERR='KFREQA'
      GOTO 1000
300   AWERR='KNFS'
      GOTO 1000
400   AWERR='KIOER'
      GOTO 1000
500   AWERR='KMINER'
      GOTO 1000
600   AWERR='KMAJER'
      GOTO 1000
1000  WRITE AWERR
      STOP
      END
```

Execution of the program can be initiated by an element in a start file. An example of such an element is given in Table D-3.

Table D-3. Runstream to Start MIP-FMPS Program

```
1   @RUN,/TP  DOH8A7,E3720T1258/H8,UNCLASSIFIED,1200,300
2   @ASG,A H8FMPSRN.
3   @ASG,A H8IMP70K.
4   @CAT,P H8ITR70J.
5   @ASG,AM  H8ITR70J.
6   @BRKPT     PRINT$/H8ITR70J
7   @TITLE,SDHPF     H8ITR70J,$150/-
8   @XQT  LIB$*FMPS9.FMPSABS
9   @ADD,P H8FMPSRN.IFMNA7
10  @ADD   H8IMP70K.
11  @BRKPT     PRINT$
12  @SYM   H8ITR70J.,,PR
13  @FIN
```

Execution time of MIP-FMPS for SRB problems of the size mentioned are highly variable. Some runs took less than an hour while others have taken nearly 12 hours. About 85 percent of the running time is input-output, and the remainder is central processing time. Average size is over 400K.

d. Postprocessor (POP). The POP is an ASCII FORTRAN, level 9R1 program, written and tested on the UNIVAC 1100/82 computer. Its purpose is to read the output file of the SRB allocation algorithm and convert that output into a "user friendly," readable format. In doing so it proceeds through a number of logical steps. These steps are:

(1) The program searches sequentially through the file for a key word. This key word indicates the beginning of required data. Having located this key it reads the maximum authorized budget, total budget expenditure, and any residual. It also reads the criticality weight points as computed by the algorithm.

(2) The program then proceeds to locate another key word. The locating of the second key word causes the program to read sequentially, the multiplier level solutions for all MOS/zones which have been considered by the algorithm.

(3) Recognizing that the PREP has preempted the entry of many of the MOS/zones into the FMPS data file, the POP compares a predetermined listing of all MOS/zones against those found in the output of the algorithm. Whenever an MOS/zone is not found in the algorithm output, a multiplier level solution of "0" is assigned to that particular MOS/zone, thus assuring the assigning of a multiplier to every MOS/zone. As this determination of the origin and multiplier level is made, the selective reenlistment bonus data base (SRBDB) is consulted for each MOS/zone. Transcribed and temporarily stored from the SRBDB are the values (pertinent to that MOS/zone multiplier) for the number of persons expected to reenlist, the required number of reenlistments, and the SRB costs and criticality weight points. If the allocation algorithm was not the origin of assignment for the multiplier associated with that MOS/zone, the criticality weight points are added to that mentioned in paragraph D-4c(1).

(4) The output of the POP takes two forms. The first is a sequential file list of all MOS/zones arranged in ascending order, together with their multiplier level, expected number of reenlistments, percent of required reenlistment achieved, and costs and criticality weight points. The second output includes a printed listing of this file. In addition, the listing is preceeded by a summarization of specific data. This data includes the maximum budget authorized, the total budget expenditure, the unexpended residual, the total number of criticality weight points obtained, and the total number of reenlistments expected. The last portion of the second output is a list of all MOS/zones.

APPENDIX E

TECHNICAL SUPPORT FOR THE EFFECTIVENESS AND ALLOCATION METHODOLOGIES

E-1. INTRODUCTION. This appendix presents additional information to support the SRB effectiveness methodology (Chapter 4) in paragraph E-2 and the SRB allocation methodology (Chapter 6) in paragraph E-3.

E-2. EFFECTIVENESS METHODOLOGY SUPPORT

a. Regression Model Selection

(1) Simple Regression. The objective of the regression analysis was to capture as much of the total variability as possible while isolating the effect of a unit increase (or decrease) in the bonus multiplier on the reenlistment rate. The first model postulated was the linear, first-order model.

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \epsilon \qquad (1)$$

The reenlistment rate is designated by the dependent variable Y. The Xs represent bonus level, year, and quarter, respectively. The Zs are unemployment rate, military/civilian pay ratio, and CPI. The term ϵ denotes all error sources.

(a) The prediction equation corresponding to the hypothesized model at (1) is given by

$$\hat{Y} = b_o + b_1 X_1 + b_2 X_2 + b_3 X_3 + a_1 Z_1 + a_2 Z_2 + a_3 Z_3 \qquad (2)$$

The coefficient b_1 of X_2 yields the fractional change in the reenlistment rate due to a unit change in the bonus level. (For instance, a value of $b_1 = 0.05$, means that changing the bonus multiplier from 1 to 2 would result in a 5 percent increase in the reenlistment rate.)

(b) The square of the multiple correlation coefficient (R^2), more commonly called the coefficient of multiple determination, is a measure of the usefulness of the explanatory variables in the model. It provides a yardstick for judging the success of the regression equation in explaining the variation in the data. Values of R^2 for the linear, first-order model were unacceptably low for the MOSs examined.

(2) Logistic Model. The next model postulated was a simple logistic model, the general shape of which is an "S-shaped" curve. The prediction equation is given as:

$$\hat{Y} = K/(1+e^{f}) \qquad (3)$$

where f represents the right-hand side of equation (2). The parameter K is the upper asymptote of the logistic model, and was taken as the highest value of reenlistment rate within a zone of consideration. In order to linearize (3), the following transformation was made.

$$\ln(K/\hat{Y}-1) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + a_1Z_1 + a_2Z_2 + a_3Z_3 \qquad (4)$$

The logistic model was considered as a candidate because of its shape and asymptotic property. It was theorized that a unit increase in the bonus level at very low values of the multiplier (0 or 1) or at very high values of the multiplier (4 or 5) might not yield as much return as at intermediate values of the multiplier (1, 2 or 3). (Note that the slope of the logistic curve is greater at the mid-range than at the endpoints.) The logistic model was fitted to the data of selected MOSs, but the associated R^2 values were not of sufficient magnitude to warrant further consideration.

(3) Linear Regression with Higher Order Terms. Figure E-1 shows reenlistment rate for MOS 11B over the 22-quarter (5 1/2 year) timeframe. Superimposed on the raw data points are the values of the bonus multiplier (1 or 2). The reenlistment rate profile exhibits a pronounced cyclic characteristic. Reenlistments were "down" during the spring and summer quarters and "up" during the fall and winter quarters. The cyclic pattern suggested the introduction of higher order terms in an attempt to account for more of the total variability than had been captured with the first-order linear model and logistic model. A third-order linear regression model was selected because cubic terms are needed to characterize the single point of inflection exhibited within each annual cycle. The prediction equation is

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_3^2 + b_5X_3^3 + a_1Z_1 + a_2Z_2 + a_3Z_3 \qquad (5)$$

where all terms are the same as before except for the addition of X_3^2 (quarter-squared) and X_3^3 (quarter-cubed). Equation (5) was fitted to each of the 26 MOSs in Table E-1. Table E-2 presents the simple correlation coefficient between the reenlistment rates and explanatory variable for all 26 MOSs. It also includes the correlation coefficient between the year and the CPI. The prediction equation produced improved multiple R^2 values relative to the logistic model and the first-order linear regression model. The distribution of the coefficient of multiple determination among the 26 MOSs (Zone A) is summarized in Table E-3.

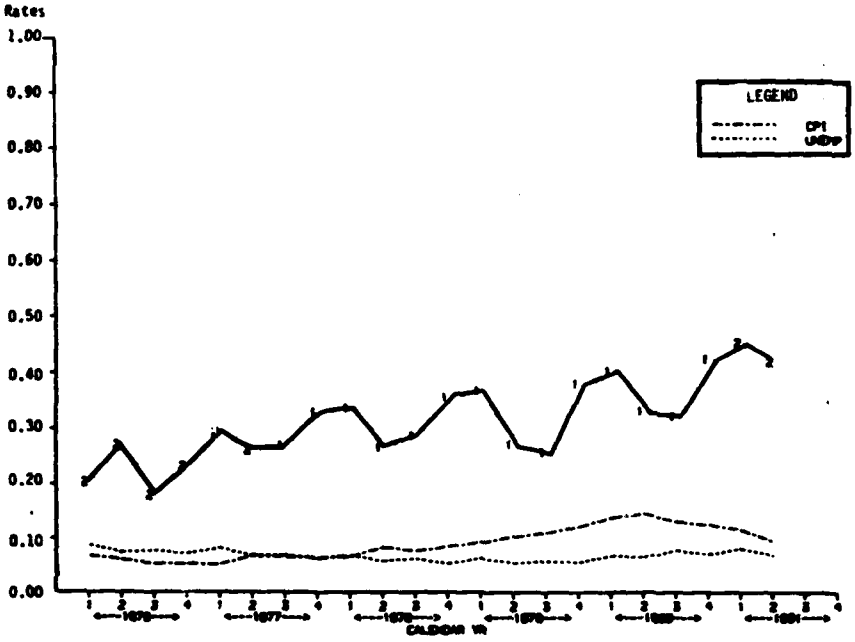

Figure E-1. Historical Reenlistment Rates and SRB Multipliers for MOS 11B

Table E-1. MOSs Investigated Statistically

MOS	Title	MOS	Title
11B	Infantryman	67N	Utility Hel Repairer
11C	Indirect Fire Infmn	73C	Finance Specialist
12B	Combat Engineer	75B	Personnel Admin Sp
13B	Bridge Crewman	91B	Medical Specialist
13E	ADM Specialist	91C	Patient Care Sp
82C	FA Surveyor	94B	Food Service Sp
16P	ADA Short Rg Ms/Crmn	31V	Tac Comm Sys Op/Mech
19D	Cavalry Scout	05B	Radio Operator
19E	M48-M60 Armor Crewman	05C	Radio TT Operator
31M	Mech Comm Eq Op	52D	Pwr Gen Equip Rep
36C	Wire Sys Inst/Op	67V	Obn/Scout Hel Rep
36K	Tac Wire Op Sp	67Y	Attack Hel Repairer
63B	Lt WVeh & Pwr Gen Mech	17K	Gnd Surv/Rdr Crmn

Table E-2. Simple Correlation Matrix at the MOS Level

MOS code	Reenlistment rate and each explanatory variable								
	SRB level	Year	Qtr	Qtr^2	Qtr^3	Unemp	Pay rate[b]	CPI	Year[a] and CPI
11B	-.2641	.8085	-.0718	.0020	.0634	-.1084		.6333	.8628
11C	-.2659	.7794	-.0766	-.0179	.0317	-.1504		.6222	.8628
12B	.3116	.6138	-.1465	-.0976	-.0485	.1877		.5509	.8628
13B	.7488	.8353	-.2079	-.1608	-.1146	-.0204		.5995	.8628
13E	-.2885	.7129	-.1882	-.1421	-.0984	-.2666	-.2323	.5417	.8628
82C	-.5211	.7489	-.2569	-.2870	-.2960	-.2862	-.2750	.5504	.8628
16P	-.3376	.4349	.0205	.0204	.0174	-.2081		.3183	.8628
19D	-.3379	.1614	.1778	.3130	.4064	.3651		.1237	.6191
19E	-.6730	.1226	-.3370	-.2336	-.1509	.5201		-.0814	.6191
31M	-.6165	.8438	-.3602	-.3345	-.3023	-.6572		.6667	.8628
36C	.2916	.5956	-.3380	-.3420	-.3339	-.0062		.5027	.8628
36K	.5740	.7258	-.4667	-.4300	-.3830	.4543		.5847	.8628
63B	.5933	.7330	-.2380	-.1753	-.1165	.4499		.7246	.8628
67N	.3604	.4111	-.3743	-.3542	-.3315	.3930		.4960	.8628
73C	-.1480	.6190	-.3942	-.3758	-.3458	-.3449		.5229	.8628
75B	-.2767	.4855	-.2428	-.1964	-.1506	-.2622		.3416	.8628
91B	-.4186	.6376	-.2578	-.1927	-.1306	-.2652		.4339	.8628
91C	-.3933	.4806	.3088	.3179	.3194	-.5506		.6823	.8628
94B	-.0562	.3804	-.3605	-.3522	-.3321	.2278		.0098	.8628
31V	.7221	.4933	-.5307	-.4606	-.3882	.6376		-.0026	.6191
05B	.1034	.6055	-.2006	-.1427	-.0734	.6396		.5637	.8628
05C	-.2323	.8040	-.1643	-.1140	-.0695	-.7551		.7182	.8628
52P	.2336	-.0370	-.4538	-.4321	-.4027	-.4072		-.2178	.8628
67V	.2105	.5189	-.1788	-.1678	-.1488	.2452		.5935	.8628
67Y	.1389	.6428	-.2658	-.2565	-.2415	.1821		.6433	.8628
17K	.0411	.2084	.0339	.0520	.0685	-.3341		.0778	.8628

[a]MOSs in which the correlation coefficient between time and CPI is not equal to 0.8628 had only 14 quarters of data as opposed to the 22 quarters represented in all other MOSs.

[b]Civilian earnings data was available for only 2 of the 26 MOSs studied.

Table E-3. Distribution of Multiple-R^2 for 26 MOSs

R^2-value	Percentage of Table E-1 MOSs exceeding R^2-value
0.80	23
0.70	42
0.60	54
0.50	73
0.40	92

b. Sample Size Analysis. Reenlistment rates represent the ratio of personnel who reenlist to the total personnel eligible to reenlist. Consequently, when the eligible pool is small, a small change in reenlistments will result in a large change in the reenlistment rate. Analysis was conducted to determine the appropriate sample size of eligibles to assure a reliable base of reenlistment rates. The Student t-distribution was used with the criteria that the selected sample size should be large enough to assure that 90 percent of the time, the observed reenlistment rate would vary by no more than ± 10 percent. The formulation used was:

$$\text{Confidence interval} = p \pm Z_{(1-\frac{\alpha}{2})}\sqrt{\frac{P(1-P)}{n}}$$

where:

p = observed reenlistment rate

α = level of significance (0.10)

P = Population reenlistment rate (0.50)

In Zone A, the overall reenlistment rate was approximately 0.50 in 1981. Therefore, the population reenlistment rate was assumed to be 0.50 in the sample size computations. Table E-3 summarizes the confidence intervals for varying sample sizes (N) and levels of significance (α). As indicated in the table, the confidence interval for a significance level of 0.10 and a sample size of 100 ranges from 0.42 to 0.58 or ± 8

percent. The next lower sample size shown is 50 at which the interval ranges from 0.38 to 0.62, or ± 12 percent. Based on this analysis, 100 separations were considered the appropriate minimum sample size for Zone A. However, if the confidence level is increased, then the sample size must increase if the range on the reenlistment rate is to remain unchanged. For example, a sample size of 100 will ensure a ± 10 percent range exactly at a 95 percent confidence level, whereas for a 99 percent level, a sample size of approximately 200 is required to maintain the ± 10 percent range. Due to the decreased fluctuation in reenlistment rates in Zones B and C, the minimum sample sizes for these zones were set at 50 and 25 separations per quarter, respectively.

Table E-4. Confidence Intervals for Reenlistment Rate 0.50 at Varying Sample Sizes (N) and Levels of Significance (α)

α	0.10		0.05		0.01	
$Z_{(1-\frac{\alpha}{2})}$	1.645		1.96		2.576	
N	Lower level	Upper level	Lower level	Upper level	Lower level	Upper level
10	.24	.76	.19	.81	.09	.91
25	.34	.66	.20	.70	.24	.76
50	.38	.62	.36	.64	.32	.68
100	.42	.58	.40	.60	.37	.63
400	.46	.54	.45	.55	.44	.56
1,000	.47	.53	.47	.53	.46	.54

E-3. ALLOCATION METHODOLOGY SUPPORT. The following arguments support assertions made in developing the allocation methodology.

a. LP Solution Near Integer. Theorem: Any basic LP solution to the SRB IP problem is near integer.

Proof:

(1) The number of basic variables in a solution to the SRB problem is one plus the number of MOS/zone in the problem. This is so since the constraint matrix contains a row for each MOS/zone and one row for the budget constraint.

(2) For each MOS/zone, q, at least one of the variables X_{qi} is basic. Since

$$\sum_{i} X_{qi} = 1$$

not all these variables can be 0 in a feasible vector.

(3) Not more than one MOS/zone can have more than one variable of that MOS/zone basic. Let Q denote the number of MOS/zones in the problem. Assigning the Q+1 basic variables to the Q MOS/zones so that each MOS/zone is given one, leaves only one basic variable to assign to an MOS/zone already given a basic variable required by (2). The assertion of the theorem is proven.

b. LP Approximate Solution

(1) Definition. The SRB problem formulation of paragraph 6-2 is assumed. As shown in subparagraph E-3a, in an LP solution to this problem the variables of not more than one MOS/zone will be noninteger. By the deviation of allocation A from allocation B is meant: (a) the number of MOS/zone in which the allocations differ, and (b) the difference in the values of the objective function attained by the two allocations. In general the deviation of an LP allocation from an IP allocation of an SRB type problem can be arbitrarily large.

(2) An LP Bound on SRB Value

(a) Introduction. The LP solution, nevertheless, does bound the value of the SRB allocation. Furthermore, a least upper bound to the width of the LP bound is available in terms of the contributions of induced reenlistments. The latter are part of the data of the SRB problem.

(b) Bound on IP Value. Definitions specified in subparagraph 6-5a will be assumed. The following relations hold for any SRB problem:

LP value $\geq$ IP value $\geq$ LP approximate value

The first inequality is true since an IP solution is LP feasible. The second inequality is true since an LP approximation is IP feasible. Thus an LP solution and its LP approximation bound the SRB value above and below.

(c) Upper Limit. The bounds in subparagraph (b) above will, in general, depend on the cost of reenlistments and the budget available for the SRB Proggram as well as the contributions of reenlistments. An upper limit on (LP value - LP approximate value), however, can be expressed in terms of the contributions of bonus induced reenlistments. For each MOS/zone let C_{qt} be the contribution obtained when the MOS/zone is assigned the maximum multiplier it is allowed. Let C_{qo} be the contributions obtained from MOS/zone when a multiplier zero is assigned to it. Then max $(C_{qt}-C_{qo})$ is an upper limit on (LP value - LP approximate value). This is so since the reduction in value from LP to that of LP approximate involves changes in the multiplier of only one MOS/zone and hence the change in value cannot be greater than the maximum contribution of the bonus induced reenlistments in a single MOS/zone. For the FY 82 data used in the test case of alternative SRB allocations in Chapter 6, the maximum contributions of the bonus induced reenlistments in a single MOS/zone is 14.11.

APPENDIX F

SENSITIVITY OF CRITICALITY WEIGHT TO CHANGES IN CRITERIA ATTRIBUTE DATA

F-1. INTRODUCTION. As is evident throughout Chapter 5, the concept of criticality weight and the manner in which it is derived is based upon a great deal of subjective conjecture. Different interpretations of the importance and use of the criticality weight leads different persons to expect different results from the mixing and matching of the nine criteria and their associated Criticality Selection Criteria Value Weight (CSCVW). Depending upon the viewpoint, the relationships between the many factors may or may not seem counterintuitive. This is demonstrated in the following example.

F-2. EXAMPLE. Table F-1 depicts Example 1 in which a notional MOS with low density and high mission essentiality is assumed. Table F-2 depicts a similar MOS with identical data except that the density is now 5,000. Table F-3 maintains all the data as shown in Table F-1 except that the mission essentiality is now changed to Level II.

Table F-1. Criticality Sensitivity, Example 1

Criteria category	Raw data	Value weight	Criticality weight
Percent of fill of the zone within the MOS	80%	40	22.92
Percent fill of the MOS	80%	40	22.92
Reenlistment rate of the zone within the MOS	50%	45	32.31
Migration rate of the zone within the MOS	20%	50	35.45
Percent fill desired in the zone within the MOS	100%	40	26.25
Percent fill desired in the MOS	100%	40	25.80
Density of the MOS	500	100	50
Training costs	5,000	1	6.09
Mission essentiality of the MOS	I	100	82.7
		Criticality =	33.82

Table F-2. Criticality Sensitivity, Example 2

Criteria category	Raw data	Value weight	Criticality weight
Percent of fill of the zone within the MOS	80%	40	22.92
Percent fill of the MOS	80%	40	22.92
Reenlistment rate of the zone within the MOS	50%	45	32.31
Migration rate of the zone within the MOS	20%	50	35.45
Percent fill desired in the zone within the MOS	100%	40	26.25
Percent fill desired in the MOS	100%	40	25.80
Density of the MOS	5,000	1	.5
Training costs	5,000	1	6.09
Mission essentiality of the MOS	I	100	82.7
		Criticality =	28.32

Table F-3. Criticality Sensitivity, Example 3

Criteria category	Raw data	Value weight	Criticality weight
Percent of fill of the zone within the MOS	80%	40	22.92
Percent fill of the MOS	80%	40	22.92
Reenlistment rate of the zone within the MOS	50%	45	32.31
Migration rate of the zone within the MOS	20%	50	35.45
Percent fill desired in the zone within the MOS	100%	40	26.25
Percent fill desired in the MOS	100%	40	25.80
Density of the MOS	500	100	50
Training costs	5,000	1	6.09
Mission essentiality of the MOS	II	50	41.35
			Criticality = 29.23

F-3. CONCLUSION. The point of this simple demonstration is that for this particular situation, the low density, medium essentiality MOS of Example 3, receives a higher criticality weight than did the MOS of high density, high essentiality depicted in Example 2. This occurrence appears counterintuitive given that mission essentiality has a higher relative importance ranking than the density. However, given the list of criteria and scalar weights used in this study, it is entirely possible that one or more criteria could dominate in the overall criticality weight computation. Further analysis of alternative criteria categories is needed to reduce the potential for criterion dominance.

APPENDIX G

ALTERNATIVE CRITICALITY WEIGHT POINT ASSIGNMENTS

G-1. INTRODUCTION. The formulation and development of criticality weights (CW) were described in Chapter 5. Paragraph 6-4f discussed the use of the CW in developing criticality weight points as an element of the allocation model's objective function. This appendix presents alternative methods of computing criticality weight points from the CW.

G-2. LINEAR DISTRIBUTION OF CRITICALITY WEIGHTS. A linear distribution of criticality weights assumes that criticality weight points are obtained in direct proportion to the number of reenlistments that are obtained. Two methods of linearly distributing criticality weight points are evaluated in this appendix.

a. In Chapter 6, the following method was used to assign criticality weight points to each MOS/zone and SRB multiplier. Criticality weight points (C_{qi}) were calculated only for MOS/zones for which a requirement for reenlistments exists. In such cases, C_{qi} was evaluated as the smaller of:

(1) $$\frac{\text{Reenl at mult i for MOS/zone q}}{\text{Rqmts for reenl MOS/zone q}} \times \text{CW of MOS/zone q}$$

(2) CW of MOS/zone q

This method will be called the "Base Case" throughout this appendix.

b. An alternative method would be to assign to each reenlistee in an MOS/zone the criticality weight points equal to the CW of the MOS/zone. The calculation for this method would be to evaluate C_{qi} as the smaller of:

(1) Reenlistments at multiplier i for MOS/zone q X CW of MOS/zone q

(2) Requirements of MOS/zone q X CW of MOS/zone q

This alternative method will be called the "Alternative" throughout this appendix.

c. Measures of effectiveness (MOE) were identified to compare the results of allocating a $143M SRB budget using the two methods in the SRB allocation model. The MOE were:

(1) The incremental criticality weight points generated by the budget.

(2) The number of MOS/zone assigned a bonus under the budget as compared to the number of MOS/zones with a valid need for a bonus.

(3) The incremental number of reenlistments generated by the budget.

For purposes of the MOEs, incremental is defined as the difference between the results obtained without an SRB program (i.e., zero budget) and the results generated by the $143M budget.

d. The results obtained from the Base Case and the Alternative are summarized by MOE and presented in Tables G-1 through G-3. Each table compares the results obtained without an SRB budget and those obtained for a $143M budget and presents the incremental improvement for the specified MOE. Table G-2 also includes the number of MOS/zones that were determined to need an SRB award in that (1) the requirement for reenlistments exceeded expected reenlistments and (2) the MOS/zone could be expected to respond to an SRB award.

Table G-1. Incremental Criticality Weight Points (MOE #1)

	No budget	$143M budget	Increment	Improvement
Base Case	7,095	8,234	+1,139	+16%
Alternative I	1,151,980	1,257,450	+105,470	+9%

Table G-2. Number MOS/zone Assigned an SRB as Compared to the Number MOS/zone Needing an SRB (MOE #2)

	# MOS/zones that need bonus	No budget	$143M budget	Increment	Improvement
Base Case	392	0	355	+355	+90%
Alternative I	392	0	184	+184	+47%

Table G-3. Incremental Number of Reenlistments (MOE #3)

	No budget	$143M budget	Increment	Improvement
Base Case	56,818	59,707	+2,889	+5%
Alternative I	56,818	60,816	+3,998	+7%

e. General observations about the results from the two methods of assigning criticality weight points are as follows:

(1) Optimal allocations of the $143M SRB budget were different for the two methods of assigning criticality weight points.

(2) The Alternative offered more bonuses to MOSs with large reenlistment requirements than did the Base Case. This resulted in more reenlistments, but less overall utility (as measured in criticality weight points) and less coverage of needy MOS/zones.

(3) The Base Case achieved more overall utility for the $143M and covered more needy MOS/zones. It tends to favor MOSs with smaller reenlistment requirements, consequently it achieved less improvement in the number of reenlistments than did the Alternative.

G-3. NONLINEAR DISTRIBUTION OF CRITICALITY WEIGHTS

a. A linear distribution of criticality weight, i.e., assigning the criticality weight points to an MOS/zone by multiplier in proportion to the number of reenlistments obtained is not an absolute necessity of the SRB study allocation methodology. It is only essential that the criticality weight points assigned to an MOS/zone multiplier reflect the desired weight that the program manager feels corresponds to the reenlistments obtained at that multiplier.

b. An alternative distribution of criticality weight to form criticality weight points that has prima facie plausibility is in the form of a concave function of the proportion:

$$\frac{\text{Reenlistments at multiplier i for MOS/zone q}}{\text{Requirements for reenlistments MOS/zone q}}$$

c. To illustrate the use of a concave function to develop criticality weight points from CW we present the following numerical example of a specific concave function. The letter t will denote the smaller of:

$$(1)\quad \frac{\text{Reenlistments at multiplier i for MOS zone q}}{\text{Requirements for reenlistments MOS/zone q}}$$

and

(2) 1

The following function of t, q(t), is concave:

$$q(t) = 1.3t \qquad \text{for } 0 \leq t \leq .5$$

$$q(t) = .65 + .7(t-.5) \qquad \text{for } .5 \leq t \leq 1$$

When CW = 20 the following table compares the criticality weight points for the Base Case with the criticality weight points assigned by the concave function q(t).

t	Criticality weight points	
	Linear distribution	Concave distribution (q(t))
.1	2.	2.6
.5	10.	13.
.7	14.	14.8
1.	20.	20.

d. Time schedule of the SRB Study did not permit further investigation on nonlinear distribution of CW to form criticality weight points.

GLOSSARY

1. ABBREVIATIONS, ACRONYMS, AND SHORT TITLES

adj	adjusted
admin	administration
ADP	automatic data processing
ADPE	automatic data processing equipment
AR	Army regulation
ARB	Analysis Review Board
ARSTAF	Army Staff
ASCII	American Standard Code for Information Interchange
asst	assistant
AV	audio-visual
avn	aviation
BEAR	Bonus Extension and Retraining Program
beh	behavioral
biol	biological
biomed	biomedical
BLS	Bureau of Labor Statistics
BMDP	Biomedical Statistical Software Package
CAA	US Army Concepts Analysis Agency
cbt	combat
CEABREP	Cost Effectiveness Analysis of Bonuses and Reenlistment Policies
chem	chemical
cir	circular

CMF	career management field
comm	communications
CPI	Consumer Price Index
CSCVW	criticality selection criteria value weight
CW	criticality weight
DA	Department of the Army
DAPC	Department of the Army Personnel Center
DCSPER	Deputy Chief of Staff for Personnel
def	defense
DOD	Department of Defense
DOT	Dictionary of Occupational Titles
EEA	essential elements of analysis
elect	electronics
ELIM-COMPLIP	Enlisted Loss Inventory Model-Computation of Manpower Programs Using Linear Programming
enf	enforcement
engr	engineer
ENT	ears, nose, and throat
environ	environment
eq	equipment
EW	electronic warfare
1-RPM	First Term Reenlistment Projection by Military Occupational Specialty
FMPS	Functional Mathematical Programming System
FORTRAN	formula translator
FY	fiscal year

GAO	General Accounting Office
gen	general
GYMPY	Year Group Management Program
HQ	headquarters
HQDA	Headquarters, Department of the Army
Inc	incorporated
incpt	intercept
intel	intelligence
IP	integer program
IPR	in-process review
JUMPS	Joint Uniform Military Pay System
lab	laboratory
LP	linear program
lt	light
MACOM	major Army command(s)
MAEBR	Management of Enlisted Bonus Recipients (Study)
maint	maintenance
mech	mechanical
med	medicine, medical
mil	military
MILPERCEN	US Army Military Personnel Center
MIP	Mixed Integer Program
MIP-FMPS	Mixed Integer Program of The Functional Mathematical Programming System
MOS	military occupational specialty(ies)

MOSB	Military Occupational Specialty Training Cost Handbook
MPA	Military Personnel, Army
MP/CP	military pay/civilian pay
msl	missile
mult	multiplier
NSPATC	National Survey of Professional, Administration, Technical, and Clerical Pay
OASA (M&RA)	Office of the Assistant Secretary of the Army for Manpower and Reserve Affairs
OASD (MRA&L)	Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)
occup	occupational
ODCSPER	Office of the Deputy Chief of Staff Personnel
OMB	Office of Management and Budget
opns	operations
PA	public affairs
pam	pamphlet
PEN	program element number
petro	petroleum
phy	physical
PIA/YOS/OFM	Personnel Inventory Analysis/Year of Service/Objective Force Model
PMOS	primary military occupational specialty
POC	point of contact
POP	postprocessor
PRB	Product Review Board

PREP	preprocessor
qtr	quarter
reenl	reenlistment
REUPS	reenlistments
RMC	regular military compensation
rqmts	requirements
RRB	regular reenlistment bonus
SAG	study advisory group
sci	science
SCIF	selection criteria importance factor
seprs	separations
spec	specialist
SRB	selective reenlistment bonus
SRBAM	selective reenlistment bonus allocation model
SRBCWM	selective reenlistment bonus criticality weight model
SRBDB	selective reenlistment bonus data base
SRBEM	selective reenlistment bonus effectiveness model
SSPP	shortage specialty proficiency pay
sup	supply
svc	service
sys	system
TDY	temporary duty
topo	topographic
unemp	unemployment
US	United States

USAAA	US Army Audit Agency
USAFAC	US Army Finance and Accounting Center
VRB	variable reenlistment bonus
vs	versus
YOS	years of service
yr	year

2. MODELS, ROUTINES, AND SIMULATIONS

SRBAM	Selective Reenlistment Bonus Allocation Model
SRBCWM	Selective Reenlistment Bonus Criticality Weight Model
SRBEM	Selective Reenlistment Bonus Effectiveness Model


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